1983

Faster building for industry

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Part I Report of the Steering Group

1 Introduction and key findings

1.1 It is widely felt that the process of procuring new industrial or commercial buildings is unnecessarily long and difficult, and it has been suggested that the process takes longer in the UK than overseas.

1.2 For the most part these allegations have been unquantified. The then Secretary of State for the Environment, Mr Michael Heseltine, offered to make resources available to the Building EDC from his Department's research programme for an authoritative study of construction times in the UK and the factors affecting them. The EDC took up this offer and we were set up as a Steering Group drawn jointly from the Department and the EDC to guide the work. The intention was to base the findings on objective data and also to cross-check them with informed opinion in the industry. Research was therefore commissioned both from the Building Research Establishment, which carried out individual case studies and statistical analyses, and from Kenchington Little & Partners, who interviewed a selection of development agencies, inward investors, professional practices and contractors. Part I of this publication reports our conclusions and recommendations. All our findings and recommendations (in italics) can be traced back to the detailed case studies, and they are generally supported by the informed opinion survey and the wide statistical analyses. Part II sets out the detailed findings of the research team, Part III reports case studies and Part IV contains the appendices. These Parts need not be read in order. For example, Part III contains both a general summary of the case studies and informal histories for a selection of them (Chapter 17). Those with a practical interest in the building process may find that Chapter 17 gives a particularly graphic impression of the wide range of performance encountered, and the reasons for the differences.

1.3 The EDC gave us the objectives:

'to establish the key factors that affect the time taken to construct industrial buildings, to identify best practice in planning and maintaining control of construction periods and to formulate recommendations for action by client, designer, and contractor.'

Industrial buildings were chosen for this, first, phase of the study because they were a sector of building of importance to the economy in the short and medium term and one where speed of construction was generally acknowledged to be important because of the need to react to market changes. The research was to cover the whole process from a customer's recognition of the need for new industrial space to his entry into a complete and operational building.

1.4 Our aim was to find out how the present best standards could be made the norm. We did not expect to produce proposals for completely new and radical reorganisation of the construction process. We were also not concerned to find the recipe for maximum speed regardless of other factors, although acknowledging that, very occasionally, speed is of absolutely overriding importance. We were primarily concerned with the scope for improving the overall pace of construction in normal circumstances, where cost and quality must be controlled so that the customer receives a building that meets his requirements at a price he can afford, is ready when he needs it, and is built to standards that ensure a long and trouble-free life and adequate flexibility in use.

1.5 *The research has shown that the British construction industry can deliver quickly and efficiently in the right circumstances.* This is true both for the 'traditional' arrangements, which we define for the purpose of this report as those in which the customer has separate relationships with a design team and a contractor, and non-traditional arrangements such as 'design and build' contracts. But the range of performance found in practice is very wide, both in the planning (pre-construction) period, and in the time taken for construction itself. For example, the average construction time for buildings costing around £0·5 million was 9 months, but 10 per cent took less than 6 months and 10 per cent more than 13 months. In the main, the range of construction times reflected different attitudes in setting targets, although about one half of the projects overran their contract times by a month or more.

1.6 *We believe this research clearly demonstrates substantial scope for improving the general pace of construction of industrial buildings without sacrificing quality or increasing cost.* We believe such improvements would benefit the customer, and also that the discipline of achieving them would be beneficial to the construction industry. The prime responsibility for achieving improvements must lie with the industry itself, and many firms, both of consultants and contractors, have been experimenting with alternative ways of organising the process. However, customers also have an important role in improving standards by knowing what they can reasonably expect and insisting upon getting it. Inexperienced customers are dismayed by the complexities and uncertainties that face them in procuring a new building. Yet, in practice, it is the customer's determination to achieve quick construction which is decisive, because the industry is performing very variably at present. This report, therefore, contains a substantial body of recommendations to the customer, as well as to the industry.

1.7 Our key findings may be summarised as:

- The general belief that speed costs money is quite unfounded – fast building is possible without sacrificing either cost or quality. The customer must want it and must choose a building team which will understand and share this objective. Responsibilities within the team must be clearly defined and in particular the customer must be clear as to who is the team leader.
- In practice, most projects which went well were for experienced customers, and were ones in which the customer supplied a substantial and well-directed management input. The industry needs to do more to fill the management gap left if the customer does not have the experience or does not wish to provide this input. The traditional method of organisation involves the customer in different relationships with several firms, and many inexperienced customers were dismayed at the complexity of the process.
- Inexperienced customers need advice and the industry has not made it easy for them to be sure they are getting the advice best suited to their needs. They should seek it from an architect, engineer or quantity surveyor, or from one of the building firms which offers design as well as construction services. The choice of what will be referred to as the 'principal adviser' in the remainder of this report should be made after considering alternative methods of organising the project and examining the track records of several firms.
- While traditional methods of design and tendering *can* give good results, on average non-traditional techniques tend to be quicker, and within the traditional approach, both tendering on bills of approximate quantities and

choice of contractor with a negotiated tender lead to faster progress.

– Ground conditions, possible obstructions and supply and location of services should be investigated and kept in mind from an early stage – preferably starting before the site is purchased.

– Preparation of the design must be directed towards facilitating progress on site:

– the design must take account of 'buildability' – that is, allowing the procurement of materials and the performance of the different building operations to be planned and organised as straightforwardly as possible with the minimum scope for disruption;

– if special materials, plant and equipment with long delivery times must be used, they should be ordered during the design stage whenever possible;

– any design contributions from specialist consultants, sub-contractors and suppliers must be obtained in good time and be properly coordinated;

– work on site must be based on full information, communicated clearly and in good time.

– The contractor should not be chosen only on the basis of price. The personnel proposed should be examined as well as the firm: the abilities of the site manager and the builder's back-up team are crucial. Early recruitment of the contractor to the building team (before the design is finalised) may help in programming, anticipating site problems, and producing a cheaper and more buildable design.

– Sub-contracting is widely used for a variety of reasons, and is in some cases essential. Extensive sub-contracting is often associated with slow construction but it need not be, as evidenced by the fact that among different methods of organisation, management contracting, in which all the work is sub-let, achieves one of the best average performances on time. Sub-contracting adds extra elements to the management chain and the level of management resources provided to co-ordinate the project and to direct and supervise work on site must be commensurate.

– Good progress on site requires high levels of site management with good back-up from the builder's firm, good communications with design team and client, and a clear and detailed programme used actively to chase progress.

– Variations due to unexpected site or soil conditions may be unavoidable. However, variations introduced by the design team or the customer as the work proceeds are frequent causes of or excuses for delay. Variations which can be agreed on the spot and do not hold up progress need not cause much concern, but those that have to be settled by reference back or which upset the programme should be avoided whenever possible.

– It is not the form of contract which primarily determines whether targets are met, but the attitudes of the parties, to which the form of contract may contribute. The standard form of contract offers penalties for delays but not incentives for speed. Industry and customer should look for ways of sharing the benefits from improved performance.

– Delays outside the control of either industry or customer will become relatively more important if, as we trust, the general pace of the industry's operations improves. The most important seemed to be:

– delays caused by statutory undertakers, who were repeatedly criticised;

– problems with the administration of the Fire Prevention Act, which causes more difficulties than planning procedures or building regulations.

1.8 Chapters 2 and 3 which follow give our conclusions on matters which can aid speed or cause delay as a project proceeds, with recommendations addressed both to the industry and its customers. They are organised broadly chronologically, Chapter 2 dealing with the preparations for construction, Chapter 3 with the construction process itself. Chapter 4 steps back from the progress of a particular project to consider more generally how the industry should be presenting itself to the customer and the service it should be offering. Chapter 5 sets out matters the customer should consider *before* he takes the step of appointing the person who will be leading his project (his 'principal adviser'), if he is to obtain the best service the industry can offer. There is inevitably a little duplication between the latter two chapters and Chapters 2 and 3, but they mainly cover separate ground. Readers in the industry could read Chapters 2–4 in sequence. *The potential customer could read Chapter 5 first and then Chapters 2 and 3.*

2 The pre-construction phase

2.1 *The time taken between the customer identifying his requirements and construction starting is normally longer than the time spent on construction itself. This pre-construction stage also sets the whole tone and pattern for the building process.* The research shows that projects which move quickly in the pre-construction phase tend to be constructed quickly as well – contrary to what would be expected if hurried preparations were leading to problems and delays later. At this state the customer has a great deal of influence – he has much less opportunity to speed things up when construction has started. *The customer's initial analysis of his requirements, choice of method of organising the project, and choice of principal adviser, are crucial.* These are discussed in Chapter 5. Once customer and adviser come together, the first task is to prepare a detailed brief.

The brief

2.2 Too often work has been put in hand without the designer sufficiently clarifying the customer's needs, the customer not having analysed them sufficiently himself, or without the customer understanding what he was getting because he was unable to read drawings. This wastes time and money. In one extreme case, the customer realised when the building was going up that it was not at all what he wanted and called for a significant amount of demolition. *Taking a brief is a very specialised task to be undertaken by an experienced person who should give it great care. The designer should try to gain a full insight into the customer's operations, by spending several days with his firm, and then give him the fullest possible picture of what is and what is not possible.*

The site

2.3 Delays were frequently caused by problems connected with the site which were discovered only after work started. These were connected either with soil conditions, obstructions, etc, or with services which were either wrongly located on plans or not identified at all. Provided that the need to deal with these problems is properly taken into account in the programme, the cost of doing so is very small in comparison with the cost of the project, except in extreme cases – eg where there is severe contamination. It will be more expensive if redesign is needed after labour and materials have already moved onto site. An increasing proportion of development is taking place on sites which are being re-used, and such sites generally need more detailed investigation than green-field sites. In any particular case, a balance will have to be struck between the substantial cost of an exhaustive site survey and the risk of extra cost and delay arising from an inadequate one. The research suggests that present practice tends to err in the direction of paying too little attention to investigatory work. *As much information as possible should be obtained before a site is purchased. With the traditional process, the design team should take full responsibility for advising on the need for and nature of site investigation. Separate contracts for site preparation can be helpful in ensuring that any problems are dealt with at the proper stage.*

The design

2.4 Design should incorporate 'buildability' – making it easy to plan procurement of materials and the moving of the various trades on and off the project, and minimising the possibilities of disruption by external factors. Simple designs using readily obtainable standard materials and components generally facilitate speedy construction. Design can reduce the risk of delays due to inclement weather, for example by allowing early fixing of cladding and roofing before floors or other internal works are started. Designs capable of speedy execution are more likely to be achieved when procedures are used which bring into play the contractor's expertise on buildability either early in the design process or at least before the design is fully frozen. Even if a contractor is chosen after the design has been finalised, he should be invited to suggest modifications which will improve buildability and construction speed or reduce cost either during construction or in subsequent maintenance.

2.5 Frequent and full communication between the customer and the designer helps them interact effectively and speeds up final acceptance of the completed design. *The customer must be organised to answer designer queries authoritatively and at short notice.* The general objective should be to freeze the design when the customer is satisfied that the balance achieved between competing and conflicting requirements is the best obtainable. The customer should note that any changes after that point are likely to cost money and/or time (even cost-saving reductions in the work can be achieved more economically if agreed as early as possible). If any doubts remain about the finality of the decision, eg if design changes seem likely in the light of information not yet to hand, special arrangements with the designer should be made, including the fixing of deadlines for changes. *Where part of the design is to be contributed by specialists, this contribution should be built in at an early stage, and not left as an area of uncertainty which may require modifications later.*

2.6 *The customer's advisers should ensure that the customer knows what design features facilitate or hinder quick construction where these matters have implications for the customer's requirements from the building. The builder's expertise should be brought in if possible. The design should, as far as possible, move speedily to a finalised form, and the degree of finality should be understood by all parties. The principal adviser must take responsibility for coorindating the design work of any specialist consultants or sub-contractors – and ensuring that complete and consistent details will be ready for the contractors.*

Choice of main contractor

2.7 *Considerable care should be given to the choice of the contractor or a short-list of contractors to be invited to tender.* Before a contractor is selected to tender, enquiries should be made about the personnel who would be handling the job. The track records of both firm and staff should be investigated. The firm's capability of bringing the project to a successful conclusion may depend on the scale of other demands on their capacity at the time, their financial stability, their experience with the type of building, and their experience in the geographical area (knowledge of local suppliers, sub-contractors, etc). The customer and/or his principal adviser should be satisfied that a contractor chosen after competitive tender has a realistic detailed programme for the job.

2.8 Final selection of the contractor through competitive tendering on a full bill of quantities should offer the assurance of achieving the lowest price from a contractor for the job as specified. On the other hand, early involvement of the contractor may lead to design changes which make construction more economical, and contractors' overheads are increased by unsuccessful tendering. The earliest involvement of the contractor is achieved by choosing on the basis of recommendation and interview followed by negotiations on price. This process was successfully used in a number of the case studies.

2.9 If time is important, this should be made clear to potential contractors, and they should be given any information that could help them plan for early completion. Tenderers should be given a clear indication of the construction duration envisaged, the importance of completion on time and the value, if any, to the customer of earlier completion, of the scale of liquidated damages, and of the need for a detailed work programme that can realistically be maintained.

Sub-contractors

2.10 Against the background of today's complex construction process, the employment of sub-contractors has become more widespread. The term 'sub-contractor' is an all-embracing one, covering organisations ranging from individuals offering only labour to specialist firms operating nation-wide. In what follows, some of our conclusions are directed only at particular types of sub-contractor, while others are general observations, which may apply with different weight in relation to different categories of sub-contractor.

2.11 Properly managed and co-ordinated, sub-contracting can lead to speedy and efficient construction, but the research documented many examples of delays in the construction stage associated with poor co-ordination (without necessarily apportioning blame for the breakdowns). Thus, for example, under the management contracting system, the deliberate strategy is for the contractor to let out all the work, often in numerous relatively small packages. Management contracting generally produces faster than average construction times, and, indeed, was used in some of the fastest projects. However, with more traditional routes, the research showed that projects tend to proceed more slowly if most of the work is sub-contracted, and/or there are large numbers of sub-contractors. Designs which require individual sub-contractors to return to the site for several phases of work produce sequencing problems and are associated with delays. Sub-sub-contracting produced management problems in a number of cases studied and there were a number of examples of delays arising from the use of nominated sub-contractors. The main contractor is normally responsible for securing the performance of both nominated and domestic sub-contractors, and has similar contractual relationships with each. However, in the cases referred to, delays could be attributed to the main contractor being unable to establish a sufficiently effective working relationship with a firm which he did not select. Sub-contracting is more prevalent in southern England, and construction times in the south were generally longer than in the rest of the country, although there is no firm evidence of a causal relationship.

2.12 *Employment of specialist sub-contractors is essential for some of the highly specialised tasks in modern construction. In these circumstances, the specialists to be nominated should be identified at an early stage. The co-ordination of the design work of these sub-contractors must be the responsibility of the principal adviser and they must be properly involved in the programming of the job.* There may be a temptation to nominate specialists to 'design and supply' simply to reduce or defer the workload on the main designers and specifiers. Following this course may lead to disruption of the construction programme, either because incompatibilities between the main design and the requirements of the specialists are identified at too late a stage, or simply because the proper flow of finalised working drawings to the project is upset. Sub-contractors may be reluctant to put much effort into design-work before they have a contract: if so, *they should be separately paid for this.*

2.13 The main contractor may sub-contract the work of general trades for his own management reasons. This need not cause delay if there is sufficient input of management resources to co-ordinate the work. However, in some of the case studies, sub-contracting of most of the work was associated with a lack of commitment by the contractor to the project and hence with ineffective management and supervision. Reluctance to employ operatives directly also sometimes caused contractors to lose adequate control over their own capacity. Use of large numbers of sub-contractors produced far greater problems when the site was inadequately managed.

2.14 Sub-sub-contracting similarly complicates the management structure, but is sometimes unavoidable for specialist work (eg duct work for heating and ventilating contractors) and need not cause problems if properly managed.

2.15 Although there is no reason to avoid sub-contracting as such, *sub-contracting of nearly all the work, use of very large numbers of sub-contractors, and use of sub-sub-contractors should be avoided unless it is part of a deliberate and properly organised management strategy. Design should minimise the number of different trades needed and the number of visits by any one trade, allowing them to come onto site and leave it with their job complete. In traditionally organised projects, nomination should be used only where there is a good reason for it, and the nominees should be brought into the process at a suitably early stage.*

Contractual arrangements and basis of payment

2.16 *Contracts successfully completed in a short time are those where good relationships and common objectives are established between the customer and the building team, mutual trust is established, particularly on the question of fair payment, and there is a clearly designated and responsible project leader throughout the preocess. Details of the contact tend to be of small importance where these conditions are met. However, current standard forms of contract, although binding the parties, tend to be concerned with distributing and limiting responsibility rather than focussing it.* The standard form provides penalties in the form of liquidated damages, but not bonuses for early completion. This is likely to encourage the setting of pessimistic 'safe' targets, and the accumulation of all possible excuses in case they are missed. Liquidated damages no doubt serve in some measure as an effective threat. However they are, in practice, rarely enforced, and overruns are not generally seen as a threat to the reputation of either the design team or the contractor.

2.17 There was no evidence that imposing a harsher or more risky regime on the contractor would improve performance: English law does not permit imposition of punitive damages in contracts, and in none of the case studies were any of the standard reasons for claiming extension of time deleted. Some sort of justification can usually be found for overruns if minds are concentrated on the subject: but they should not be. All too often, after a few setbacks, attitudes on a job change from a determination to complete on time to a concern to document sufficient reasons for not doing so. Efforts to improve performance should be focussed on finding ways of setting up (and subsequently running) projects so that this change of attitude will not occur.

2.18 The system of stage payments means that the cost of financing a slow operation largely falls on the customer. On simple economic grounds, optimum pace would be expected if the cost of delay fell mainly on the person who had prime control of it. In the case of a project which could be brought into partial use before completion, the order of work which produces the best cash-flow for the contractor (the maximum value of work completed per month) may not be the same as the order which optimises the customer's cash-flow (by enabling him to make some use of the product at an earlier stage). *The customer should consider the possibility of paying on the basis of sectional completion (provided for in a supplement to the standard form). If, for example, he is commissioning a number of units, he should investigate arranging payment based on unit handover. In general, if early completion is valuable to him, he should consider passing on part of this value in incentives (for example by means of a target contract).*

3 The construction phase

Management

3.1 The quality of performance during this phase will, to a large extent, already have been determined by the quality of the preparatory work. The research also indicates that *it is important to establish good management continuity between pre-construction and construction. Providing that the job has been properly set up, the most important factor in securing speedy construction is the establishment of effective site management with an adequate back up team and resources for the site manager within the contractor's own organisation.* The manager should be given authority to make decisions himself as far as possible, and, where reference back (eg to the architect) is unavoidable, a mechanism must be established for him to get quick replies. *Strong site management, good communications, and quick decisions on questions which arise during the construction process are of paramount importance to the successful implementation of a well planned project.*

3.2 The research also shows that the customers who have achieved quick results tend to be those who have taken a continuing and detailed interest in progress. *Customers should make active use of the detailed work programme to chase progress.*

Variations

3.3 *The ability to introduce variations is both a strength and a weakness of the traditional British contract system.* Minor variations can often be accommodated without disrupting the programme when good relationships have been established between the members of the building team, and some variations can even speed the process. However, *variations emerge from the research as one of the important causes of delay, and they can also be used as excuses for delays.* In general, the delays arising from the need to get new decisions were more significant than the delays arising directly from the changes in the building work required. Absolute freezing of a design before construction starts is probably rarely feasible. *Minor variations should, if possible, be negotiated on the spot to minimise disruption of the programme. Variations which will significantly disrupt the programme should be introduced only where there is good cause, and in full knowledge of the disadvantages. The alternative of constructing to the original specification and modifying the building after completion should be considered.* (The research showed that advance developers, in particular, need to do this: some of them allowed their projects to be greatly disrupted by their efforts to respond to demands from prospective tenants.) Where the possibility of changes can be identified, or detailed decisions are deliberately delayed at the design stage, points at which decisions are essential or changes will become expensive should be identified on the project programme.

External influences

3.4 There are several sources of delay outside the direct control of the industry and its customers. Unpredictable extreme weather conditions are one, although even here design and timing of the work can be so arranged as to minimise the risks. Planning and building regulations approval was not generally critical to the progress of projects since programmes were arranged to allow design and other work to continue while consents were awaited.

3.5 In a number of cases, however, difficulties were reported arising from

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the variety of external interests in fire safety – notably from the functions of fire prevention officers under the Fire Precautions Act 1971 which are distinct from the requirements of the Building Regulations. The requirements of insurance companies with regard to fire precautions were sometimes stricter than the requirements of either fire or building control officers, but their interest covers protection of the building and contents as well as the occupants. The Building Regulations apply to new construction, alterations and changes of use, and are administered by the district councils (except in Inner London). Part E of the Regulations sets structural fire safety requirements for all building work, and means of escape requirements for some types of building (flats, maisonettes, offices and shops). The Fire Precautions Act provides for fire certificates covering such matters as means of escape to be issued for premises designated under the Act, namely hotels, boarding houses, offices, shops, factories and railways premises. The fire prevention officer, a county official, is responsible for issuing the certificate for the completed building before it is occupied. Where there is overlap between the Regulations and the Fire Precautions Act, the Act strictly limits fire officers' powers to require structural alterations.

3.6 The difference between the two statutory procedures was not always understood and programmes were disrupted because proper account was not taken during the design stage of the fire prevention officer's interest. Despite the limitations on the fire prevention officer's powers, there can be difficulties with speculative buildings since the end-use is not known, and even non-structural alterations can produce design problems. There were also complaints of significant differences between the interpretation of the Fire Precautions Act by fire prevention officers in different parts of the country. *Most of these difficulties can be anticipated and forestalled if the principal advisers understand the system and consult fire prevention officers on the design at an early stage.* Use of an adviser who is locally based should help to ensure that he knows the local requirements, but *the government should seek to encourage the development of general codes and standards for fire safety and the industry should realise that the statutory requirements are limited to the protection of life and do not extend to the preservation of property. Insurance companies could usefully consider further the scope for bringing their requirements closer into line with each other and with statutory requirements.*

3.7 Much the largest body of complaints about external influences related to statutory undertakers failing to fit their operations into construction schedules. Statutory undertakers are often not prepared to accept the disciplines in terms of timing of their operations and reinstatement which other parties to the process accept under normal contractual arrangements. Efficient construction requires that they should do so. On the other hand, designers must recognise that statutory undertakers may not be able to accommodate the demands of new developments within their existing supply networks at short notice. Whether or not substantial physical problems are involved, the difficulties can be minimised by consulting statutory undertakers at the earliest possible stage in any project. *Principal advisers should be aware of their responsibilities for early consultation with the statutory undertakers and the anticipation of potential problems.* The National Joint Utilities Group (NJUG) has recognised the need for a better framework for communication and co-operation between the statutory undertakers and builders. We welcome the preparation of model guidelines for the servicing of new building developments, drawn up by a Working Party of NJUG, the National Federation of Building Trades Employers, and the House Builders' Federation. These will provide a benchmark against which the performance of all parties can be measured. *The operation of the guidelines should be monitored and their effectiveness reviewed after a reasonable trial period.*

4 The industry's approach to the customer: the service the industry should offer

Finding the customer

4.1 In the case studies, inexperienced customers frequently reported difficulty in knowing how best to approach the industry to get services they needed. *Firms offering project management, design or design and construction services should do more as individuals or through representative organisations to make their services and their particular specialities known to potential customers.*

First contacts with the customer

4.2 The research shows that poor customer performance frequently contributes to delay. It also shows that inexperienced customers tend to be dismayed by the complexities and uncertainties presented to them. The industry's objective should be to show the customer that his needs and wishes are paramount and can be met. The industry will, of course, also have to make sure the inexperienced customer understands his role. When his project is discussed, it may be necessary to explain that certain of his wishes could lead to avoidable costs and delays. But this should not be done in such a way as to intimidate the customer, give him the impression that he must adapt his needs to suit the industry rather than vice versa, or otherwise set the relationship on an adversarial course rather than a basis of partnership.

4.3 *The industry must be able to respond flexibly to customers' varying knowledge of construction and varying abilities to communicate with the industry. Once a customer is identified, the nature of the partnership between him and the participants from the industry should be carefully explained. The scope and flexibility of the industry's services should be made clear, while warning, where necessary, of choices that may produce avoidable cost or delay. The customer should be told, for example, about the possibilities for changing his requirements as the project proceeds, and also about the time and cost penalties which may arise from such changes.*

Approach to pace

4.4 Customers will usually opt for brisk construction if they are offered it and more of them will be prepared to embark on new building if they know it is a speedy process. This gives the industry a clear interest in securing a business-like pace. From the outset there is also the consideration that the faster the project moves, the sooner professional fees and payments for construction will begin to flow. As the project proceeds, and particularly when the contractor moves on site, there are expenses related to an unnecessarily slow pace that are not always given due prominence: expenses of maintaining a presence on site, and the more minor expenses of financing costs and retentions longer than necessary. *The research suggests that perhaps the industry's scarcest resource is good site management: this resource should certainly not be tied up longer than necessary on a particular job.*

4.5 There are, of course. off-setting advantages in a more leisurely pace, in that it offers those involved flexibility in moving resources between projects, *but we believe the general feeling that speed always costs money is quite unfounded.* Indeed, in one case study a new manager took over a project that was running behind budget and was able to make it profitable only by speeding it up. *The industry – both designers and the construction team –*

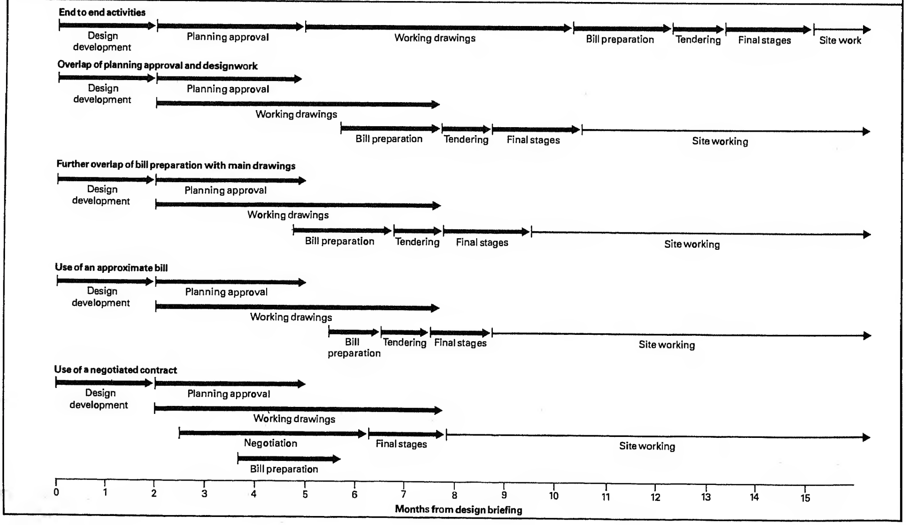
should make a practice of calculating in each case how much each week or month's saving of time would cost or save. They should encourage the customer to do the same, and then seek to achieve common objectives with him on project time and seek arrangements to benefit from any time savings they can deliver.

Organisation and programming

4.6 *The research shows that the traditional methods of design and tendering, the various design-and-build options, and project management can all give good construction times.* On average, however, use of non-traditional routes tends to produce overall project times shorter than those produced by traditional routes. Within the traditional approach, progress tends to be faster if tendering is based on bills of approximate quantities, or a contractor is chosen and a price negotiated.

4.7 The traditional approach to construction has been associated with a sequential approach to the various processes in producing a building, although in this report 'traditional' is used to refer to the relationships between parties rather than the details of sequencing. Savings of time are achieved by overlapping the various processes and possibilities are illustrated in the diagram. Some are available with any method of organisation – for example, that of keeping design work going while awaiting planning permission. All those illustrated are possible with variations of what is referred to as the traditional route in this report. Some may be easier to achieve with non-traditional routes, and non-traditional routes lend themselves more readily to more radical compression of the process – for example, by integrating and overlapping the preparation and planning for construction with the development of the design, or by starting construction before detailed design work is complete.

Figure A The pre-construction timetable



4.8 Within the traditional route, preparation of the two sets of documents – drawings and Bills of Quantities – which together contain design and specification should be able to proceed largely in parallel if architect and quantity surveyor work effectively together. Tendering on the basis of full bills limits the scope for further telescoping. *Use of approximate bills or of negotiation in selecting a contractor allows more savings in time, since the contractor can effectively use the time needed to complete the design to organise and prepare for the project and programme the site work with all sub-contractors.*

4.9 *Design consultants should consider whether they could develop the capabilities and resources to offer design and management packages, and similarly construction companies should consider whether they could develop management contracting or design-and-build services for customers to whom time is important.*

4.10 Exploration of the scope for pursuing several activities in parallel emphasises the need for a detailed work programme. *The research also shows many delays – eg failing to order special materials early enough – which should have been avoided by proper programming.* The detailed programme for the project should be drawn up by the principal adviser on the basis of the deadlines for completion set by the customer. It should subsequently be kept up to date and firmed up as the project proceeds. Customer's decision points should be clearly identified. *The programme should cover all activities involving the customer and his professional advisers (eg land acquisition, financial approvals). It should be used at an early stage to identify activities that could cause hold-ups if delayed until a contractor is appointed (eg site and soil survey, contract with statutory undertakers, ordering of specialist supplies or materials with a long waiting time).* Once the contractor has been appointed, he should prepare and agree a detailed construction programme indicating the start, duration and sequence of all major operations, including those of the sub-trades, and identify those on the critical path. Schedules should be drawn up to indicate dates for key items of information, nominations, ordering of materials and numbers and movement of labour. *The contractor should use the programme as a basis for controlling, co-ordinating and monitoring progress of all the trades during the construction process.*

4.11 *Customer and industry should see that a detailed work programme is drawn up and understood by all parties. It should identify critical decision points. The discipline of preparing it should be used to ensure that processes are overlapped as far as possible at all stages, and once it has been prepared it should be used actively by the customer and his principal adviser for chasing progress.*

Project leadership

4.12 Confused lines of responsibility and poor communications crop up as causes of delay at all stages of the process and with all types of organisational arrangements. *The participants from the industry and the customer should know where responsibilities lie at each stage, and who within each organisation can give authoritative answers to queries. The arrangements must allow adequate management continuity between pre-construction and construction, so that somebody is responsible both for the design and the consequences of it.*

Role of the design and specifying professions

4.13 The research shows great differences between the performance of different architects, even within one type of contractual arrangement. It indicates that achieving fast construction within the traditional framework requires them to be good project managers as well as designers. In one case study a 7000m^2 building was designed and constructed by the traditional method in less than 45 weeks from the decision to proceed. The architect visited the site twice a week and had a good relationship with the site staff. In a contrasting case, a 9081m^2 building took 160 weeks and was 14 months late. The architect was inexperienced and located a considerable distance from the site. It is not, of course, suggested that this was the only difference between the execution of the two projects. But the architect is the most usual first point of contact for the customer with the industry, and is likely, therefore, to have a particularly strong influence in setting the tone for the project. Close involvement of an architect in project execution should lead to improved consciousness of 'buildability' in future work.

4.14 Late supply of mechanical and electrical engineering details is a frequent cause of delays. Sometimes consultants are reluctant to finalise choice of plant, in order to keep options open for competitive selection on the basis of price. But unless the contractor has specifically agreed to produce detailed designs himself incorporating schematics from the consultant, the drawing supplied to him must incorporate full details – not merely line diagrams of services. *It is essential that M&E consultants regard themselves and are regarded as full partners in the design team, and that their contribution to the design is made at the appropriate point, early in the design process, and is properly coordinated.*

4.15 *The principal design consultant must ensure that all the contributions to the design are fully coordinated before construction starts. Thereafter, within the traditional framework, he should take an active interest in the progress of the job on site – making regular visits and ensuring that he is accessible to answer queries. Training of the design professions should include first-hand experience of work on site.*

4.16 The quantity surveyor's interest in the specification process remains an important check on the design as does his assistance to the customer in getting value for money. Where speed is essential to a project, his role is likely to move towards that of an independent cost adviser operating within a flexible framework.

Role of the builder

4.17 The research demonstrates the increasing demands on the management abilities of builders as the complexity of the building process increases. It also illustrates the value to the customer of relatively early involvement of the builder's expertise in the planning process – both in helping to achieve a design incorporating buildability and economy, and in helping to achieve a firm and speedy programme for the construction work, by alowing early ordering of specialised materials and adequate planning for dealing with any site problems. All this suggests that *builders should, in general, look for opportunities to play a wider role in the building process – whether this is by offering design and build or management contracting services, or even by taking on the role of entrepreneurial developer.* Such moves would be advantageous to builders both in giving them more work in connection with individual projects and in opening up wider markets to them the market based on simple price competition is likely to narrow if there is a continuing move away from the traditional methods of organising projects.

5 The customer's role: the service the customer should demand

5.1 This chapter gathers together considerations the customer needs to have in mind before he selects the firm and person in the industry who will lead the project (his 'principal adviser'). Thereafter, the customer should be guided by Chapters 2 and 3 on the pre-construction and construction phases of the project.

Customer's management input

5.2 Industrial buildings differ greatly in their degree of specialisation, but every building project is to some degree unique. A building should be tailor-made to the customer's requirements even if standard components and systems are used, and even though customers and their financial backers will want to aim for flexibility where possible in case they subsequently want to dispose of the building. Customers will, therefore, always have to play a considerably greater part in the process than they do in the process of manufacturing a mass-produced machine which they purchase. Customers also differ greatly from one another. Some have an almost continuous building programme and a high level of in-house expertise, while others will build once a decade or once a lifetime.

5.3 There is a minimum of customer involvement in specifying requirements and answering questions – and this will be affected by whether a relatively standard or a highly specialised building is required. *The customer should make sure that a senior member of staff, who can take decisions without reference back, will be available for consultation when required. It is also to the customer's own advantage to ensure that someone is acting as a focal point for his interests, either in-house or outside but working closely with him.*

5.4 *The research shows that at present if a customer wants a building quickly, he must be prepared to take on a good deal more than this minimum involvement. The industry's performance varies greatly from firm to firm, and the industry will not generally offer quick design and construction unless pressed to do so.* The customer's behaviour is, in practice, paramount in determining project duration. *If the customer wants a building as quickly as possible without incurring abnormal costs, he should make this clear at the outset and insist upon it. It should be a factor in his choice of principal adviser and he should ask whoever is appointed for a programme from which to monitor progress. The responsibility for progress-chasing should be taken by the principal adviser rather than the customer, but the customer's keen and obvious interest should concentrate the minds of all concerned.*

Identifying the need

5.5 Although professional advisers can help to formulate the customer's requirements into a brief, in the last resort only he can decide what these requirements are. Failure to consider them in the necessary depth at the outset will almost certainly lead to delays, and probably increased costs later on. Working through his requirements with professional advisers may show that better use can be made of existing buildings. *When a customer has decided to have a new building, or to alter an existing one, he should involve all users in formulating what he requires from the design. The proposed use of the building should be critically examined. A move to a new building provides a* *rare opportunity for a complete reassessment of and radical changes in his operation. The further that planning can start ahead of the decision to build, the better.*

The importance to the customer of speed

5.6 Time will be of overriding importance to certain customers. The building may, for example, be essential for a new process which must start by a certain deadline if an order or a market opportunity is not to be lost. More often, however, time is one factor to be balanced with others. Most customers regard cost as their priority. Achieving the greatest possible speed will add to cost – costs will rise if more people have to be brought on site than can work together really efficiently, and if unsocial hours are worked. Extreme speed may also carry a penalty in quality. However, these are hypothetical statements. *The research shows a wide variation in construction times* for comparable buildings without great differences in the cost or quality of building. Indeed, when projects were put out to tender, the same tenderer often offered both the lowest price and the shortest construction time. There was one case in which a project was running at a loss to the builder and was brought into profit only by speeding it up. *There is scope for substantial improvements in the average construction times offered by the industry without penalties in cost or quality.*

5.7 The feeling emerges from the research that, *if a project receives the management effort necessary to get it completed quickly, the same discipline will help keep costs down and quality up.* Furthermore the research also shows that *projects planned to more leisurely and 'safe' time targets tend ultimately not to finish on time, so acceptance of a slow programme gives the customer no guarantee that it will be adhered to.*

5.8 In assessing the value to him of savings in time, the customer should consider, as well as the cost of the building work, the cost of financing the land acquisition and stage payments on the partially constructed building before he starts to reap any benefits. There may also be the cost of alternative accommodation while he is waiting to move in. On the other hand, he may feel it would be easier to finance a longer construction process, or he may decide that slower progress offers useful opportunities to modify the requirements as the building proceeds. *Before deciding what he will ask for from the industry, the customer should calculate accurately how much each week or month saved is worth to him. His planning should work back from the date his machines can be installed and the objective should be to work with the industry to define the optimum duration for the project (see paragraphs 2.15 and 4.5).*

Organisation of the building team

5.9 The customer has to choose both the type of organisation to be used for the project – the lines of responsibility and the contractual relationships – and the firms or individuals who will play the individual roles. The choices are discussed separately, although in practice the customer may, quite reasonably, choose the personnel on their merits, attaching less importance to the particular form of organisation they are offering. This report can do no more than outline the different types of organisation available and their relative merits. Although the assessment given here is not confined to considerations of speed, it is not exhaustive, and the potential customer may also wish to consult one of the 'client guides' listed in the bibliography.

5.10 The traditional process involves the customer in separate relationships with consultants preparing the design and specification and with the contractor carrying out the work. This offers the advantage of independent professional advice on the building process, and also makes the introduction of variations as the work proceeds relatively easy – some variations can be priced directly on the basis of rates quoted for the various categories of labour and materials quoted in the Bill of Quantities. *Variants of the traditional process in which tenders are made on a bill of approximate quantities, or on a specification and drawings only, or a price is negotiated with a single builder, enable parts of the pre-construction activities to be overlapped, offering potential savings of time (see paragraph 4.7 and Figure A on page 14). They do, however, place a heavier burden on the design team if there is to be an equal assurance of minimising cost.*

5.11 Design-and-build contracts, in which a building contractor does some or all of the design work, can produce buildings very quickly, particularly if the contract is a negotiated one, and with a firm which will do all the design work. They may also lead to cost savings, if the builder's practical experience is of use. They are attractive to the customer because he has to deal with a single organisation – but do not automatically provide an independent professional check on the builder's work. *The customer must therefore be prepared to keep a closer watch on the process and may feel the need for independent advice from an architect, consultant engineer, or quantity surveyor in these circumstances.*

5.12 Alternatively, the customer may pass control of the development to an external organisation. Under a project management arrangement responsibility is transferred, both for design and construction, to a specialist management firm or to a professional practice – architect, quantity surveyor or consulting engineer – which offers these services. Under a management contract or construction management agreement a building firm takes overall responsibility for the construction stage only.* The lead firm is engaged only in management, all the construction work is let out to other firms. *The customer will of course, have to pay for expert management bought in in this way, but it will reduce the load on his own organisation.* Customers following this path should forge very close links between their organisations and the manager. The manager may be able to reduce times by close control of the operation, especially if he is part of a building firm which is willing to provide supervision while the work is done in 'packages'. Project management by firms specialising in this can produce excellent results, but the firm must be a sound one. Management contracting by a branch of a large building firm offers an assurance of back-up capacity if a project runs into difficulties.

5.13 Finally, customers can act as their own building contractors, directly employing trades for their own work. *This greatly increases their responsibility and internal costs but reduces external costs.*

5.14 *Customers should make the best possible assessment of the type of organisation most suited to their needs. This involves balancing factors like the extent of knowledge and experience of building available within their organisation, and the administrative load they can carry internally, with the degree of control desired over the project as it proceeds, and the extent to which they are prepared to pass on ultimate responsibility for seeing that the work is done. If in doubt, they should include on their short-list firms offering different types of service.*

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* NEDO favours use of the term 'management contracting' where the customer has a contract only with the management firm, which enters its own contracts with the firms doing the work, and the term 'construction management' where the managing firm is employed on a fee basis, and the customer enters direct contracts with the firms doing the work. There is at present, considerable confusion over the use of these terms (and of 'project management') and 'management contracting' is frequently used to refer to both types of management of the construction stage.

Choice of the principal adviser in the building team

5.15 Wide ranges of performance may be encountered in any of the organisational frameworks, and the choice of the project leader is therefore crucial. If a suitable person is not available in-house, apparently easy options, like making appointments on the basis of casual recommendations, should be avoided. The choice as principal adviser of architect, engineer, quantity surveyor, or building firm which offers design as well as construction services, may be influenced by the nature of the project, past experience, or personal preference, but care in investigating track records, or in interviewing several firms (or professional practices) pays dividends. *Customers should not pick the firm purely on the basis of cost, or of the sales pitch put up by the first representative of the firm they meet. It is essential to know who within the firm will be in day to day charge of the project, the quality of his and the firm's track record, and the other major commitments on his time. The customer should try to look at other schemes for which they have recently been responsible, and seek the opinions of those customers on the quality of service they received. He must choose someone with whom he can set up a good working relationship based on mutual trust.*

Part II Report of the research team

6 Introduction

6.1 The objectives agreed for this project were

'to establish the key factors that affect the time taken to construct industrial buildings, to identify best practice in planning and maintaining control of construction periods and to formulate recommendations for action by client, designer and contractor'.

The research was to cover all aspects of the procurement of an industrial building with the exception of local planning procedures.

6.2 It may be useful, at this point, to recall briefly the opinions and concerns that have combined into the decision to direct research to this area:

- Increasingly, it was believed that critics of construction times were voicing the general opinion. The process of acquiring a new industrial building was judged to be long, difficult and unpredictable, often jeopardising for the client the financial viability of his scheme.
- Evidence from overseas appeared to indicate that at each phase the timing of the UK construction process compared unfavourably with examples taken not only from US practice but also from other European or Commonwealth countries. It was feared that clients with international experience of construction might be deterred from building in this country.
- Several, to some extent unique, influences on UK construction since the war, such as, for example, the importance of the public client, have contributed to maintaining a system in which speed or commercial urgency were not dominant.

6.3 Thus it is 'length' or 'tardiness' that has come to epitomise most often the shortcomings in construction performance. The emphasis on 'time' in the research brief has been seen as part of this wider concern. Therefore, the investigation has not concentrated on construction speed alone, that is on high-speed construction techniques or on one-off specific arrangements for speed. The object has been to examine time performance as an integral part of the construction service and to observe how, as a result of actions, relationships and communications between all concerned, the construction process takes shape and proceeds through its various stages to the eventual completion of a new building.

6.4 It was necessary first to establish the time range of current performance in the initiation, design and execution of industrial projects and to define what represents 'normal' expectation and achievement and then to identify and appraise factors and conditions that associate consistently with the 'norm' as with deviations from it in either direction, but particularly those that achieve successful and above average performance.

6.5 A large number of clients, professionals and contractors have contributed to the research. Most of those approached welcomed interest in the subject, considered that the research was much needed and expressed support for the objectives.

6.6 The findings are reviewed in the next chapters and illustrated by case studies. Detailed descriptions of the scope of the research together with essential quantitative data, are presented as Appendices.

6.7 Included in the research programme were:

– Statistical analyses of large scale broad data about industrial projects – to give a general impression of current performance.

– Case studies of a representative sample of industrial projects – to give details of building characteristics and uses; needs and expectations of clients; methods, relationships and arrangements that apply to industrial building and how these influence performance.

– Studies of selected aspects of practice – to concentrate on successful new approaches to both the pre-construction and construction phases of projects, to probe conditions for which they are suited and the possible obstacles that may stand in the way of their wider application.

– In addition to seeking information in the context of particular projects, the research had also recourse to general experience and opinion – to seek the views of successful practitioners about factors and conditions they deem essential for good and speedy performance by reference to experience gained, both in this country and abroad.

7 The pattern of industrial building in Britain

Output

7.1 In the last few years the industrial sector has assumed an increasing importance for construction. At a time when the industry has contracted to two-thirds of its size ten years ago, it has declined at half the rate of other building work and now accounts for one fifth of new construction. Nationally, the value of output of industrial construction was £2900 million in 1980.

7.2 The distinction between public and private customers is less important in the industrial than in other sectors of construction: public customers account for less than 10 per cent of output, practically all of which consists of advance factories for local authorities and industrial development corporations on behalf of private users.

7.3 The research also found evidence of considerable latent demand for industrial buildings. Large numbers of prospective customers had shelved their projects and expected to revive them as soon as either their own market outlook or general economic conditions improved.

7.4 Of the 8–9000 projects for industry started each year two-thirds cost less than £50 000, but these account for only 10 per cent of the total output. Many are alterations rather than new work, but a considerable number of projects are for small units which attract tax relief. At the other end of the scale, few projects are worth more than £2 million each. This study has concentrated on the middle range of projects, between £200 000 and £2 million; however, sufficient examples from outside this range have been included to give a comprehensive impression.

Types of building

7.5 Industrial construction was divided roughly equally between factories built by industrialists for their own use and speculative developments. The majority of buildings were single storey, often with a two-storey office. Most buildings had office space: in purpose-built projects this could be up to 50 per cent (average 20 per cent) compared with an average of 10 per cent for advance factories.

7.6 There was also considerable variation between projects in their cost per unit of floor area. This ranged from less than £100 per sq m to over £400 per sq m depending on whether special services and equipment were included. On average, advance buildings had a lower cost per sq m than purpose-built ones.

7.7 The design of the buildings was determined by the process they housed in only one-third of the projects studied; other projects built for owners had some specific features such as crane gantries, special floors, ventilation systems, services and, in many cases, superior office finish. Many small manufacturers combined 'head office' and manufacturing unit. Fundamentally, however, industrial units were of very similar forms of construction: steel framed, with brick or metal cladding and asbestos cement roof covering; the emphasis in their planning was on flexibility in use.

7.8 Speculative 'advance' units were designed for a dual function as either production or storage units and had eave heights of 5·5 metres and more (this often caused heating problems for the small manufacturer).

7.9 Most advance units were rented. A few developers offered completed units for sale and found overwhelming response, indicating that among industrial users there is significant demand for standard, 'off the peg' type, factories.

Finance

7.10 Private speculative developments were predominantly funded, directly or indirectly, by pension funds, banks and insurance companies. These institutions required land to be on lease for at least 125 years to allow for rebuilding two or three times over this period. They also had implied or explicit requirements in respect of the design and layout of the units as well as of economy of running costs, eg standards of insulation, low-maintenance finishes, brick dado walls etc.

7.11 'Own-use' customers frequently sought lease-back arrangements with funding bodies and were ready to compromise on their designs to accommodate funders' criteria. In any case, in their design briefs they took note of and conformed to such standards as to facilitate the possible re-sale or letting of their factories, should their own market expectations prove them wrong.

7.12 A large proportion of the customers approached in the early stages of the study had abandoned their projects because they were unable to raise capital. Of the projects that were eventually studied, many still had financing difficulties, particularly if expenditure had to be authorised at several levels, including foreign parent companies. On several projects, financing arrangements changed during pre-construction. This could interrupt the course of the design process for indefinite periods and often also required substantial re-design.

Location and sites

7.13 The geographic distribution of industrial building paralleled that of the population quite closely; however, proportionately more was built in Scotland and less in London. It was becoming increasingly hard to find convenient green-field sites, particularly in the southern half of the country. Some customers had spent up to 3 years searching for and negotiating the purchase or lease of land. As a rule, private speculative developers purchased land from private vendors, often with the assistance of estate agents. Own-use builders depended for sites on public authorities and nationalised industries.

7.14 Negotiations for the purchase or lease of land with some local authorities were protracted and the restrictions to the use of the land could interfere with the viability of projects. Customers complained about the lack of established and efficient procedures for transfer and the considerable time it took for local authority legal departments to complete land transfers or draw up a lease. In some cases customers finally opted for tenant status in local authority custom-built units. Other authorities, however, for example, Scotland, Tyneside let it be known that they welcomed industrial users and went out of their way to provide sites quickly and cheaply. Several customers had moved away from their original location to avail themselves of such sites.

Conditions in the ground

7.15 The general shortage of sites and deliberate local authority policy to make use of 'waste' land have combined to direct industrial developments onto sites which would not have found favour with customers some years ago. Most industrial construction – 75 per cent of the case study projects – took place on secondhand sites. Without exception these projects met with unexpected ground problems during construction. This has called into question the procedures and approaches used for the survey and inspection of such sites and the subsequent design of groundworks and foundations. The sites often contained various man-made obstructions, such as foundations, sewers, cables and pipes. Information about their nature and location was missing or inaccurate or had not been pursued with sufficient determination. Construction delays caused by inadequate site surveys were considerable. In general, projects on green-field sites had construction times faster by up to 2 months than those on re-used land.

8 The timescale of industrial building in Britain

8.1 It was convenient to divide the generation of an industrial building into two phases: the pre-construction phase which included all activities and events necessary to and usually preceding work on site and the construction phase which lasted while contractors were on site and ended when the completed building was handed over to the customer. Unlike the construction phase, where the dates of start and finish were in principle clear-cut, the start of a project was often difficult to pin-point, the types of job and their sequence were variable and could be intermeshed in parts with the construction period. The pre-construction phase was often discontinuous, involved iterations and interruptions while customers developed or reconsidered their objectives.

Pre-construction times

8.2 For the purposes of the research the start of a project was taken as the customer's first project specific move, usually the appointment of a designer. The object at this stage is to design and cost the project and to produce the conditions for work to start on site. The average time from 'decision to build' to 'start on site' was about 11 months – 10 months for advance schemes and 12 months for purpose-built projects. The shorter times for advance projects reflected the effect of new government incentives for small units which spurred developers into greater speed to qualify for grants available for a limited period.

8.3 Individual projects had widely varying times but these were independent of size: short pre-construction times were six months or less, the longest over two years. Short or long periods were not simply the result of 'good' or 'bad' practice: pre-construction times were determined by how much had already been done to assemble resources for the project, eg land, design, permits, finance, before the explicit decision to proceed; the times necessary to do the professional jobs – and the customer's urgency or the deadline for the finished building. Long pre-construction periods were caused by factors largely external to construction – financial uncertainties or difficulties with acquiring a suitable site. Short times were achieved by overlapping the various activities.

Construction times

8.4 In the study average construction durations for industrial building projects ranged from 5 months for projects costing £100 000 to 12 months for projects costing £1·5 million, and 15 months for projects of the order of £3 million. The few large projects, with costs between £10–£15 million, required 17 to 20 months of site work.

8.5 For any given project value the spread of times was large – a 2:1 range, even if the fastest and slowest 10 per cent of projects were excluded. The fastest projects in the study took about half to one-third less than the average times; the slowest projects had durations twice as long as the average (this applies to projects between £100 000 and £3 million – only 3 contracts in the sample were outside this range). About one-half of the projects overran their planned times by 1 month or more.

8.6 The pace of work, measured as the monthly rates of output, increased sharply with the size of the projects (from some £15–20 000 to £750 000 and £1 million per month) with corresponding increases in site resourcing levels: the numbers of men on site rose from 9 and 10 men on the small projects to 80 to 100 men on projects costing £2 and £3 million and reaching up to 400 men in the group of very large projects. This illustrates the range in the management and operating methods and resources of contractors building industrial projects.

Total times

8.7 The fastest total times from inception to completion were 6–7 months for projects costing between £100 and £500 000; for projects from £0·5 million to £1 million fastest times were about 9·5 months and some larger projects costing up to £2 million were planned and completed in 13 months.

9 Participants in the process – customers

9.1 The studies have highlighted the key influence of the customer in the progress of the projects and the apparent difficulties of being an effective customer and obtaining maximum service from the industry. It was felt that too much of the onus was on the customer, who in general had too little guidance about how to use and what to expect from the industry.

Diversity

9.2 The customers in the study were very diverse. For purpose-built projects they included all sizes and types of firms from small family businesses and partnerships through to multi-national and corporate enterprises. Some were building for the first time or were new to the UK, others had considerable experience from building both in this country or abroad. Customers for advance projects were no less varied and included public bodies, financial institutions, development companies, as well as other companies and individuals who were acting as developers to make use of chance opportunities. Most of all, customers varied in their knowledge of construction and experience of the industry.

Attitudes to speed

9.3 The main concern of the research was customers' attitudes to the timing and speed of their projects. Very few customers were interested in speed per se or had explicitly considered the influence of time on the costs and returns from the project. In principle they were not prepared to pay extra for exceptionally fast construction projects. They wanted good value buildings at the right time but as a rule they were more vague in their notions about time than about any other aspect of building.

9.4 Customers lacked quantitative information which would guide their expectations about the times necessary for their projects; there were no generally recognised times for projects of a given size that an approach to the industry would automatically secure, as there might be, for example, for costs.

9.5 For some customers, the reasons for which they had decided to build included specific deadlines. These were usually related to tax incentives or qualifying dates for government grants or the needs of tenants. Industrialists had timetables of changes to their own process, or of orders they needed to fulfill, which were critical for the overall programme and for its particular stages. The need to have a project completed by a given date defined the customer's building needs in terms of time and certainty. The customer was only interested in building if the project would be completed by the given date.

9.6 Experienced customers knew what was achievable and the effort and time needed for the design and construction of projects. They instilled in the project team a sense of urgency.

9.7 The majority of customers were, however, prepared to be guided by the industry and accepted times proposed to them as being in the nature of the process, even if it was not what they had hoped for. After the event customers often expressed disappointment about the length of time involved. Some customers considered, or were led to believe, that faster times necessarily carried penalties in either quality or cost and always chose the lowest bid regardless of timing. However, all customers regarded the duration of the project as a matter of concern.

9.8 On the surface, developers of advance factories might be expected to have had less pressing needs for speed. However, tenant demands or tax reasons did dictate short project times in a number of cases and experienced developers were aware of the dangers of protracted or open-ended timing and preferred to see their buildings completed, leaving possible tenant requirements as a separate issue.

9.9 Advice from the industry about timing was conservative and reflected the different operating methods of the many participants and the fact that they had to fit in the project with their other commitments. This could also cause projects to drift rather than progress purposefully through their various stages, if the customer was inexperienced in the workings of the industry and unable to put pressure on his building team.

Points of entry – approaches to procurement

9.10 Customers lacked sources of information or impartial advice about the options and alternative courses of action open to them. They had no adequate means for assessing the suitability of any particular type of construction service for their own circumstances. In consequence they did not make the best use of the services the industry had to offer, eg assistance with developing briefs and specifications, various management services, package deals etc.

9.11 Projects were often organised traditionally by default rather than as the result of conscious decision, leaving the architect's responsibilities ill-defined while the customer did not have the expertise and resources to be a valid partner, and play his part effectively. Often they were not even aware that they had a choice. Several customers said in retrospect that they would have chosen a different arrangement had they been aware of the opportunity.

9.12 Customers were surprised and dismayed at the complexity of the task and the uncertainties that procuring a building involved for them. Even sophisticated industrial customers were caught out by the unpredictability of construction, particularly when they compared it with the relatively controlled conditions of their own manufacturing environment. Several first-time customers, who had made efforts to assemble information by talking to other customers with recent building experience, complained about the difficulty and the inadequate yield of their efforts. Apparently, reliable insight into the operations of the construction service could only be gained through the trials and errors of accumulated or bought in professional experience.

9.13 The customers' uncertainties in how to go about procuring a building were mirrored in the tentative way they chose their first contact if they had had no previous associations with the industry. The smaller, one-time customers often routed their approach through familiar channels like estate agents, local surveyors etc. Advice from professional bodies was found to be unhelpful in that they provided lists of local practices without any indication of relevant experience. New appointments were often made for personal rather than professional reasons, eg the consultants were neighbours, relatives, friends or friends of a friend. Only very exceptionally did customers seek references or inspect other work done by the practice and there were few instances of any searching enquiry into the practice's expertise, workload etc.

Successful customers

9.14 A few customers in the study went to great lengths to achieve exactly what they wanted. Usually they had continuous building programmes and a thorough, professional understanding of the industry. They employed building professionals or had building departments whose main function was to extract and coordinate all requirements within the customers' own organisation, draw up and agree detailed specifications, communicate expected standards, minimise change and liaise with the outside professionals and contractors. They chose outside professionals, contractors and sub-contractors with care, insisted on rigorous programmes and closely supervised the design and construction process, going to the extent of, for example, sacking ineffectual site managers or sub-contractors. Despite their business-like approach they were also very concerned to have good relationships all round, which they considered the key to success.

9.15 At the other extreme, some very small clients who were wary of delegating any responsibilities, acted as their own project managers and were equally successful.

9.16 The customers in between, the large majority, were heavily dependent on professional consultants and contractors. They rarely had a sound basis for choice (and comparison) and to this extent the outcome of their projects was a matter of chance.

9.17 Customers were often unaware, and had not been made to understand sufficiently, that they themselves had an essential contribution to make to the success of their project. At worst, they were diffuse in formulating their requirements, dilatory in taking decisions and failed to provide their consultants or contractors with a consistent contact in their organisation. Several customers were also unable to appreciate excellent performance from their building team.

10 Participants from the industry

The professionals

10.1 In the projects studied both architects and engineering practices acted as designers. Projects with a high technical content, where the building was of secondary importance and seen mainly as the envelope to house process plant, were led by engineers. Usually in these cases, the engineers were also responsible for the design of the buildings; this often extended also to the construction and installation of plant.

10.2 The practices ranged from small one-man offices to large multi-disciplinary and international consultancies offering a wide range of design and management services. In general, the professional practices in the case studies were not short of work, as was the case with contractors.

10.3 Various management services were also offered by developers, contractors and specialist management consultants.

10.4 Architects were involved in the majority of projects. Most often they were retained by the customers to design and supervise their projects. Where non-traditional arrangements were used, customers employed architects either to design only or to advise them in the preparation of detailed briefs. On a number of projects architects were retained by design-and-build contractors, although the majority had their own in-house designers. Some customers employed architects to advise them during construction and it was not uncommon for customers subsequently to retain the same architect who had designed the project for the design-and-build contractor – an arrangement which worked well for all parties.

10.5 Experienced customers were able to be clear-cut in their requirements about the design and about all other functions and tasks they expected from their architect. However the first approach of the inexperienced or first-time customer was usually to an architect and the indeterminate nature of many such commissions made it difficult for architects to gauge the work content. Instructions were often too vague or summary to define the implied workload and to give the architect a realistic indication of the effort involved in respect of design and other responsibilities.

10.6 There was also evidence of architects failing to establish from the start an effective dialogue with the customer, enquiring into his expectations and standards, and making sure of being properly understood by customers with no experience of construction or of the UK construction market. They did not react with sufficient flexibility to customers' differing abilities to communicate and interact and they either did not advise them sufficiently on procedures, customs and consequences in respect of particular actions or applied them too restrictively. Some customers found it difficult to visualise their buildings from drawings, particularly if in their brief they had given only a verbal description of their needs. In the study only one architect said that it was his policy to 'live in' first with the customer to get a 'feel' for his requirements; such an approach was more frequently used by design-and-build specialists or project managers. Questionnaires to be filled in by the customers were not considered effective; they told the architect little and customers found them difficult to understand.

10.7 Only few projects in the study had written briefs and over half the customers had left it to the architect to distil and to work up their requirements into practical design directives. Arrangements to separate briefing formally from the main stream of the design were rare. It was similarly rare for customers to 'freeze' the design or formally agree to adhere to the brief; on site, drawings with a dozen alterations were not unusual.

10.8 Fees for design varied: on most projects they were based on the contract value (4–6 per cent) and included supervision; lump sums were used on smaller projects. The usual arrangements were for weekly site visits, in some cases twice weekly. Several architects provided a continuous presence on site, others used clerks of work. It was not immediately obvious whether and in what ways fees accurately reflected the amount of work done. For example, on a self-build project the architect visited the site regularly and gave practical advice throughout for a £750 fixed fee. On other contracts, with RIBA fees for large projects, contact with the customer and the site was entrusted to inexperienced junior technicians who had difficulty in attending site meetings and fitting in with the customer's dates. Experienced customers and project managers had generally negotiated fees below or at the lowest end of the margin.

10.9 Virtually all projects also had quantity surveyors. Mostly they were used to produce bills of quantities and oversee payments, but customers employed quantity surveyors also in more general ways to look after their financial interests, eg to advise on the pricing levels of negotiated contracts, on variations etc. Parent companies and institutions appeared to prefer this additional protection. Several small projects dispensed with bills and quantity surveyors altogether. Most were design-and-build and self-build projects. Only on one traditional project were lump sum quotations sought against the architect's specification and drawings.

10.10 Most projects used old version JCT contracts (63 with 77 revisions) despite the issue of JCT 80 which was considered too complicated. Several customers used their own contracts or those of institutions. Use of JCT 80 was generally rejected by those interviewed in connection with the study. (The work was, however, carried out while JCT 80 was very new, and this situation may have changed.)

The main contractor

10.11 Main contractors in the study varied very widely in size, specialisation and the services they offered – from the very largest national organisations to small family firms. Annual turnovers varied from less than £0·5 million to over £100 million. The turnover of the main contractors did not necessarily correspond with the numbers of their employees, which varied from very few to more than 6500, largely because sub-contractors were used to widely differing degrees.

10.12 Contractors' policies towards employing site labour varied; at one extreme they had hardly any directly employed tradesmen or labourers and relied on a more or less stable – but informal – network of domestic sub-contractors to do the work on site. On over one-third of the sample projects none, or very few, operatives were in the main contractor's employ. When the main contractor lost control over the supply of site labour, shortages of labour and delays occurred on a number of sites. At the other extreme, some firms employed directly virtually all building trades.

10.13 Contractors specialising exclusively in industrial building were rare and were confined mostly to projects where the provision of process equipment was central to the project and the buildings were a secondary element in the package. Most contractors were general builders operating in the industrial, commercial or office sectors and concentrated on industrial buildings in different ways: some were developer/builders often co-financing the building process, others specialised in producing standard ranges of factories, of which many were system based. Several developers and builders offered management contracting services and a growing number of contractors concentrated on design-and-build packages designed to provide industrialists with a comprehensive service covering both building and the installation of plant.

10.14 All contractors had preferred ranges of projects, both as to size and location, which they considered were best suited to their capabilities, operating pattern and command of resources. They preferred to use locally based management with good knowledge of local conditions. Smaller contractors restricted their working area to a 40-mile radius, the larger offered coverage from regional offices. The conventional wisdom that 'the success of projects diminishes with their distance from head office' did receive some confirmation from both the statistical analyses and the case studies.

10.15 The resources and method of working of the main contractor were important for the rate at which projects were built. On small contracts progress and speed were determined by the time necessary to do the tasks that comprised the job and the spacing between sequential tasks. Most of these projects were done by smaller builders at output rates of some £20 000 a month.

10.16 Larger projects provided more opportunity to design for and open up larger numbers of workstations on site and to work with higher resource concentrations overall. For speed and efficient rates of progress such projects depended on contractors able to command the necessary manpower and provide the attendant management skills and supervision.

10.17 Some customers and their professional advisers used thorough and well-prepared selection procedures aimed not only at the main contractor but also at sub-contractors and suppliers. These were, however, infrequent compared to selecting contractors on price only without additional evidence about their performance record.

10.18 Contractors in the study who experienced difficulties during construction often were either inexperienced in industrial building or were operating outside their area and could not effectively muster local labour and sub-contractors. The most frequent cause of failure was inadequate management and supervision on site. Shortage of work had also caused a few contractors to tender for work for which they had not the necessary resources or accept construction times which they did not genuinely expect to fulfil.

Sub-contractors

10.19 The use of sub-contractors was much more extensive in the south of England than in the rest of the country. Of the projects studied in the south, over three-quarters were wholly or mainly sub-contracted compared to only about one-third in the rest of the country. Construction times outside southern England were generally faster.

10.20 Because of its large part in the construction process, sub-contracting had the most far-reaching effect on construction times overall: only one in ten of the projects on which all or most trades were sub-contracted had fast construction times compared to one in three of those which used directly employed labour for most of the work. This reflected the difficulties in planning, supervising and bringing together contributions coming from a large number of disparate sources rather then the performance of sub-contractors alone. The organisation, motivation and performance of sub-contractors were no less varied than those of main contractors.

10.21 Sub-contractors were extremely diverse; they included, on the one hand, specialist suppliers of frames, cladding, services, various equipment, components and finishes – often larger and more sophisticated than the main contractor – most of whom were selected by the customers or designers during pre-construction and who contributed both to the design and the construction of the projects; and, on the other hand, small local builders who undertook work on behalf of large national contractors, or self-employed gangs of tradesmen or labourers who provided labour only services.

10.22 Difficulties in the relationships between main and sub-contractors arose in most or all of five areas: design information, attendance, supervision, quality of workmanship and 'snagging'.

10.23. Sub-contractors often sub-let part of the work, thus extending the lines of communication and management even further. The general impression was that while sub-contracting had grown very rapidly in recent years for a number of reasons, its implications had not as yet been assimilated effectively into the procedures for the design, organisation and management of construction. Because many sub-contractors contributed to both the design and execution of the projects they did not fit in easily with the traditional distribution of project responsibilities.

11 Statutory factors

Planning approvals

11.1 Planning approvals did not cause undue delay, approvals being generally obtained within two and three months; only on one-fifth of the projects did planning approvals require more than three months. Several authorities, anxious to increase employment opportunities, made special efforts to speed permissions. In one case a party visited an industrialist's existing factory in another area in order to grant permission for a similar building without detailed drawings. Approvals were easily obtained in new towns and were generally slower in Greater London where four months was the 'norm'.

11.2 Approvals were fast where local authorities had been actively involved in initiating the development, for example as part of an industrial estate. Speculative developers encountered more difficulties and delays than purpose builders. Disagreements or conflicts of interest were mostly about the number and type of units to be put on a site. Individual authorities had different preferences about site coverage, density, landscaping etc, and the complaint was that these were nowhere explicitly stated or published. For this reason some developers preferred to appoint local professionals because they expected that familiarity with the authority's implied standards and idiosyncracies would be an advantage. However, several architects stressed that 'being strangers' assured them of even more careful attention to their problems. Generally it was good practice to have informal discussions before submitting a formal application. In one case eight schemes were put forward before the ninth was accepted, all in the span of nine weeks.

11.3 Specific problems arose for non-conforming users, and where sites were located in city centres, conservation areas and national parks. There were delays and customers felt that planners' requirements about design details, landscaping and screening were excessive.

11.4 To minimise the effect of any planning delay on pre-construction, design work usually continued while approvals were processed. A quarter of the projects went to tender before receiving planning approval and in a few urgent cases work had started on site before planning permission was received.

Building regulations approval

11.5 Building regulations could take a considerable time to be processed. This was not necessarily critical because on half the projects work started on site before approval was obtained.* On average the time for obtaining approval was three months, but for individual projects this varied between one and eight months.

11.6 Fire regulations were a particular problem. Authorities varied in their interpretation and this caused different standards to be applied in different areas. Some insisted on cladding steel columns even if they were incorporated into a brick or block wall. Several architects used concrete frames to avoid this problem. Cladding of walls to achieve fire protection was complicated where party-walls coincided with the portal frame because the infill was time consuming to erect. Rigid or too strict interpretation of the regulations often led to designs than conflicted with the efficient or effective use of the buildings. Some officers would not allow windows between offices and warehouses, others refused to allow reception desks in entrance halls on the ground that they caused obstruction. (Insurance companies often made even more stringent demands.)

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* This is not possible in Scotland where approval must be obtained before work starts.

11.7 Fire officers were not obliged to accept features agreed with the building control officers. Requests for additions and alterations made during construction extended site times on a number of projects by up to five weeks. Some authorities encouraged simultaneous consultation of both officers to lessen the possibility of late design changes.

Statutory undertakers

11.8 Difficulties with statutory undertakers supplying gas, water, electricity and drainage had a significant effect on progress in over half the projects. The general complaint was their lack of urgency which was often exacerbated by bureaucratic restrictions. Examples were long delays before they replied to letters, produced estimates or started work, requirements for long advance notices, demands for pre-payment and complicated payment procedures, excessive charges, excessive demands in respect of standards of finish, eg burma teak doors which subsequently had to be painted red for electricity sub-stations.

12 Methods of organising projects

General

12.1 The projects in the study were organised by a variety of methods. Within each, responsibility for the design, planning and construction of the project was distributed in a different way and each also provided different scope for overlapping and integrating separate activities. Together they offered customers a spectrum of different types of service which affected also the extent of their own participation and control. The case studies give insights into the ways the different methods have been used in practice and their relative performance.

12.2 At one end were traditional arrangements where customers were expected to take an active part in the management of their projects. At the other extreme, under design-and-build arrangements, most of the customer's management responsibilities and control were transferred to the contractor. Along this spectrum, a number of customers had appointed various specialist consultants to manage the project on their behalf and relieve them of some tasks and responsibilities. They did this without necessarily changing at the same time their arrangements for the design and construction of the project. The consultant's role could, however, extend further in different directions – to managing the construction process, or both design and construction or they could assume responsibility for the project from its inception to completion. Alternatively, customers could centralise most or all activities under their own management. The refinements of each arrangement assured it of a specific application within the wide variety of industrial projects and customers' needs.

12.3 Non-traditional methods were more likely to achieve fast project and site times. In the study – with one exception – all projects with times half or a quarter faster than average were organised in non-traditional ways. There were, however, examples of fast and slow projects in each group.

12.4 The various formal categories of project organisation included, in fact, a variety of different approaches, management styles and competence; in judging the success or failure of individual projects all attendant circumstances had to be considered and similar reasons for fast or slow projects recurred in each group.

Traditional arrangements

12.5 Over half the customers in the study used the traditional method of appointing a consultant designer, usually an architect, as their principal protagonist in the project: to design the building, coordinate the contributions of other specialists, select the contractors and supervise construction on site. Design and construction were separate, tendering for construction was usually competitive and design work largely complete before work started on site.

12.6 Speculative customers used traditional arrangements more often (60 per cent of advance schemes were traditionally organised, compared to 40 per cent of purpose-built projects); they were concerned about the 'market' appeal of their buildings and wanted to retain control over, for example, details of appearance, quality of finishes etc. Many customers who used traditional arrangements were experienced, understood the system and were well-equipped to direct the project in ways best suited to their needs; the majority of these projects had total and site times within a 10 per cent range around the average.

12.7 Inexperienced customers also used traditional competitive arrangements, but often with less success and because they were unaware of alternatives.

12.8 Specific difficulties for the timing and progress of traditionally organised projects were caused by lack of focus of management responsibility and coherent concern to see the whole project through, as well as the relatively late involvement of the main contractor and his consequent difficulties in planning and programming the work.

12.9 'Fast' traditional projects relied on 'exceptional' personal qualities, eg commitment, enthusiasm etc, and various compromise arrangements to overcome inherent obstacles, eg 'no nominations'. One-third of the traditionally organised projects in the study had better than average total or site times.

Separate management function

12.10 About one in five customers had used various specialists to assist them in the organisation and management of their project and to give themselves certainty that their intentions and targets were understood and achieved. The majority were 'own use' customers, but several public and private developers had also taken this approach. As a broad group, such arrangements were mainly used by experienced customers and for projects where customers needed quick completion by specific deadlines.

Project management

12.11 Several customers had appointed a project manager to act on their behalf within what still remained an essentially traditional arrangement. Project managers were used equally for large or small contracts: the projects ranged from £0·25 to £2·5 million. Project managers in the study performed a wide range of tasks: they found and negotiated sites, arranged financial backing, formulated initial briefs, negotiated with planning authorities recommended and negotiated with architects, consultants, process plant suppliers and chose contractors. Usually they had previous experience of working with the consultants they recommended. The choice of contractor was, as a rule, based on competition – with full or approximate bills. Contractors were chosen not only on cost but on time, management calibre and performance record: in awarding contracts, project managers used their discretion to advantage, a discretion which under normal traditional arrangements had often not been explicitly given or assumed by the architect. Project managers' fees were usually 1 to 3 per cent of the contract sum. On most projects pre-construction was fast (3 to 5 months). Barring a few exceptions, construction was also efficient. In the study, project managers had been used more often by customers with experience of construction and not as might be expected by the first-time customers.

Other management arrangements

12.12 Other management arrangements, frequently used, were management contracting, which in some cases extended also to the management of the design process, and integrated design and management contracting, where the construction manager's function was taken by the designers of the project. Under these arrangements design, procurement and construction planning were increasingly becoming more coordinated or centralised allowing the various activities to develop largely simultaneously.

The savings on total and site times resulted mainly from early and comprehensive preparation and programming of site construction.

12.13 They also focussed attention on designing the projects for construction as a sequence of self-contained operations with minimal interference between them and thus acknowledged the practical realities of sub-contracting on sites.

12.14 Special management arrangements were often used to start work on site before design was complete to give the customer flexibility as well as the certainty that particular deadlines would be met.

Management contracting

12.15 The most commonly used management arrangement was management contracting, where the main contractor was replaced by a specialist in site management who worked for a fee. In most cases they were in fact large national contractors. Their appointment at an early stage allowed for early and integrated procurement, planning and site preparation and generally widened the range of construction expertise available to the client at this stage. Management contractors did not undertake any of the physical work on site, they let the construction to contractors in a number of packages, mostly by competition, often on approximate bills and co-ordinated and directed the work on site. They brought together and put to good use the services of small local builders who individually would not have had the resources to handle the larger projects and the project still had the backing of a large contractors' resources and capabilities (for example pressing suppliers for quick deliveries and making good any labour shortages from their own resources). Management contractors were often used to arrange for an early start on site while details of the design were finalised.

12.16 Several developers also offered management contracting services without necessarily having their own construction resources. Their contribution was based in the first place on their relationships with contractors they trusted and had worked with before. They concentrated on dividing the work skilfully into tailormade packages and left the management of the work as well as co-ordination and sequencing to the contractors themselves. Their supervision was effectively restricted to cost control and they produced successful results at very low costs. These two types of management contracting illustrate how a 'formal label' which described a type of contractural arrangement in reality covered a variety of quite different approaches. Management contractors were used on both small and large projects.

Fast tracking (serial tendering)

12.17 On one project the management contractor's role extended to both design and construction. The contract was undertaken by a management consultant specialising in what he called a 'fast tracking' service. This gave the customer maximum flexibility in developing his own requirements together with the certainty that short and precisely timed deadlines – dictated by his production process – would be met. The consultant programmed and coordinated all design and construction work and provided full-time site management. With the help of the professionals appointed to the project, he sub-divided the project into relatively small self-contained packages to be designed and let for site construction as a sequence, fully interleaving the pre-construction and construction phases of the project and arranging them around the timetables of changes in the customer's production process. The outcome was efficient although costly, both in terms of fees and the total cost of the project, but the customer had balanced the cost against the consequences of failure to achieve his objective.

Integrated design and management contracting

12.18 Several customers used an integrated design and management contracting service. The projects all had a high process content and the service included the design of the process or at least the conceptual layout of the process plant. This approach was used for relatively smaller contracts as well as for very large and complex schemes of the order of £12 million to £15 million. On these, the entire project including all processes and related services was planned and executed with the detail and precision comparable to that of a military operation. Design, procurement of materials and equipment and construction were integrated into one comprehensive programme which was backed also by detailed procedure manuals defining all working arrangements, responsibilities and lines of communication. The consultants worked for an agreed fee, sometimes enhanced by bonuses and penalties related to both time and costs. On some projects there was an element of competition: the customer first invited a wider group of consulting firms, against reimbursement of their costs, to participate in the development of the brief. A preferred concept then formed the basis for tenders. No main contractor was involved but in some cases a separate fee was paid to the contractor who made the most substantial input (usually civil and structural work) for also supervising the sub-contractors on site. This approach gave very efficient pre-site and total times: for example, from appointment to completion a £12 million project took under 2 years: 17 months on site preceded by 6 months of detailed design work. The management contractor had a central task force for the project and a management team on site. For very complex projects customers usually also had a full-time back-up team. The same principles were used on smaller contracts, but procedures and personnel were on a scale appropriate to the size and complexity of the project.

Management in-house by the customer

12.19 One customer in ten in the study decided to manage their projects themselves, using approaches that mirrored the various specialist management arrangements described in the previous chapter. They all dispensed with the main contractor but used outside design expertise to a varying extent.

12.20 Some were speculative developers who had in-house site management expertise. Their objective was speed because they concentrated on short-term, tax or grant linked opportunities. The projects were generally small and included relatively simple units. They employed designers to design the buildings and negotiate with planning authorities, then let the frame and cladding to specialist suppliers and employed labour-only sub-contractors for the rest, achieving very fast project times indeed.

12.21 Another group consisted of first-time industrial customers building factories or workshops for their own use who opted for management in-house after a 'traditional' start to the project had produced estimates which were too expensive for their budgets. They had no construction experience; a senior partner or executive coordinated construction with some clerical assistance. Their professional advisers chose and adapted the designs so as to be suitable for sub-division into a number of packages, advised on tendering procedures and conditions of contracts and visited the site. None of these projects ultimately exceeded £100 000 in value and all achieved the intended savings. The projects were also completed in better than average times.

12.22 An integrated own design and management approach was used by several industrial customers for projects with high plant contents which also required sensitive timing. The customers' own process engineers worked on the design and subsequently organised the supply of plant and construction.

Several such companies had gradually developed their specialist design and engineering experience to a level of skill which they were beginning to market to other industrialists.

Design and build

12.23 Some thirty per cent of the case studies, ranging from the smallest to the largest and with varying degrees of technical complexity, were built under design-and-build arrangements. They were used by all types of customer in the public and private sectors as well as by international companies building in the UK. Within the group the range of performance was very wide, but half the contracts had fast project times, finishing on time or even in advance of agreed site durations.

12.24 Customers who had chosen this arrangement saw an advantage in the single contractual relationship with the design-and-build contractor largely because responsibilities were clearly defined. They considered also that the success of the arrangement depended as much on informal relationships as on formal definition of responsibility.

12.25 The need to build on and inspire confidence was evident in the types of construction firms who had undertaken successful design-and-build contracts in the study. Two groups stood out in particular. In one were major 'famous name' contractors geared to develop and handle large and complex industrial schemes for their customers. The other group were small to medium sized local contractors who relied on a high proportion of repeat business with existing customers. On a smaller scale they also offered a comprehensive service based on in-house design, management and a multi-disciplinary workforce.

12.26 Although competitive tenders would have given customers the opportunity to compare several designs and specifications for value for money, they were used only infrequently. Some customers appointed professional advisers to assist them in their dealings with the contractor during the contract period. On large projects customers organised their own 'task force' to liaise with the contractor. Several projects had two-stage arrangements: a separate price was negotiated for the 'shell' and for 'fitting out'. This enabled the contractor to make an early start on site and allowed the customer more time for firming up his requirements for internal arrangements and services. In a few speculative projects the design and build contractor came in as a joint developer, largely financing construction from his own resources.

12.27 Several customers had turned to design and build after their architects' designs had proved too expensive for their budgets and were surprised at the level of savings they had achieved. In these and other cases contractors modified earlier designs or design briefs to save time and/or costs, to good effect. The contractors' concern for the practical aspects of buildability and speed was also often visible in the choice of materials and components or in the use of special processes and techniques. Some contractors had developed their design-and-build service around various building systems complemented by their own well-rehearsed operating procedures.

12.28 Design-and-build arrangements were less successful if there was no established close collaboration between the designer and builder, if the contractor lacked specialist experience, or if the customer's specifications were too tightly circumscribed.

13 Aspects of performance in pre-construction and design

Timing and overlaps

13.1 Compared to the unpredictability of 'external' factors, designers' and quantity surveyors' pre-tender work did not generally take long or extend pre-construction unduly. Many case studies bore evidence of flexibility and ingenuity on the part of designers and quantity surveyors to meet customers' needs for speed or particular deadlines and to adapt their approaches accordingly.

13.2 On a considerable number of projects the times for the professional jobs in pre-construction were of the order of nine months – with activities largely end-on-end; work on design co-ordination and drawings normally proceeded while planning approvals were processed:

Events	*Weeks*
Initial design and costing, acceptance by customers	0– 8 (8)
Planning application and approval	8–20 (12)
Design co-ordination and working drawings (by architect, structural engineer and services consultants)	8–31 (24)
Production of bill of quantitic	23–31 (8)
Tendering period for builders	31–35 (4)
Appraisal of tenders, award of contract and start on site	35–42 (7)

13.3 Where speed was a priority, timetables were faster. Sketch plans and estimates were submitted to the customers and approved within 4 weeks. Work on the bills of quantities was integrated closely with the progress of the design work, starting at the same time as planning approval was applied for (8 weeks into the pre-construction period). Projects went out to tender after 18-20 weeks. The time allowed for tendering and award of contract was also cut down from 11 to 6 weeks, giving an overall pre-construction period of 24–26 weeks. It was easy to prepare drawings and the bill of quantities in tandem if both designer and quantity surveyor were members of the same practice or had a tradition of working together and could resolve conflicting work commitments or priorities.

13.4 Pre-construction was also shortened by overlapping the design with the selection of contractors either by negotiations or by tendering on bills of approximate quantities.

Bills of approximate quantities

13.5 On several projects, the tendering process took place while design was still in progress and contractors tendered on approximate quantites. Most often these were cases where customers' urgency, for example to resume production after a fire at their premises, or tax or grant deadlines, had made it imperative to start on site as fast as possible and to minimise project times overall. Bills of approximate quantities were also used where the site was unpredictable or the buildings were still to be developed during construction.

13.6 On these projects, pre-construction times were fast – two or three months, and even one month – depending only on the design work required to agree a solution acceptable to the customer and the planning authorities. (The overall fastest project in the study used this approach.)

13.7 The effort it took to prepare approximate bills was about half that required for a full bill and this in itself contributed to shorter pre-construction times. Several quantity surveyors in the study specialised in producing approximate bills. The bills proved effective in identifying the lowest or most suitable tenderer. They were also accurate in their estimates of the final cost of the project if the design had been substantially defined at the point of tender and no major changes were made during construction.

13.8 For maintaining the momentum generated by this approach, good contact and a steady flow of information to the site were important. Generally, contractors were confident of being paid (payments were based on remeasurements of actual work) and therefore ready to proceed on minimal instructions.

Negotiated contracts

13.9 Time was also saved if the contractor was selected by negotiation and not by tender. The main contractor was usually appointed while design was in progress and he could use the time still needed to complete the design, to organise and prepare for the project and programme the work with the sub-contractors. Despite these advantages, negotiated arrangements with contractors were infrequent (with the exception of M & E sub-contractors and design-and-build contractors), possibly because in times of low demand competitive tenders were thought to be more keenly priced. Customers used negotiation either to appoint a specific contractor with whom they had a continuing relationship or to formalise conditions with members of their own groups of companies.

13.10 Architects often preferred to retain an element of competition and asked several – usually local – contractors to submit rates and propose budgets and programmes for the project before they made their final choice. On most negotiated projects in the study a full bill of quantities was used and customers also appointed independent quantity surveyors to assess the 'market level' of the negotiated price. The results were generally satisfactory.

Design co-ordination and procurement

13.11 Structural engineers and services consultants, where needed, were usually appointed by the architects. Architects often dealt with the structural, mechanical and electrical engineering contents of the design with the assistance of specialist sub-contractors and suppliers. Alternatively, they used consultants to prepare requirements or performance specifications and left it to the suppliers to take these further to complete design.

13.12 A satisfactory result was seldom achieved and the lack of precision, coherence and timing of information about the installation of services did cause many delays. Suppliers of, for example, lifts, process plant, air conditioning equipment etc, often directly retained by the customers, particularly lacked a sense of urgency and discipline: their data about dimensions, requirements for installation were often inaccurate or late. For example, in one case study 86 holes had ultimately to be incorporated into a precast floor slab which had been designed to accommodate 23, because of late and indistinct drawings from various suppliers, in other cases misleading data about the loads of equipment caused late design changes, racking, when delivered, interfered with the roof structure, etc.

13.13 Difficulty in co-ordinating the timing and details of the design was caused also by other specialist sub-contractors responsible for the supply of frames, cladding, doors etc, particularly if they were selected by competitive tender and were therefore unwilling to invest much effort into potentially abortive work. In some cases they were paid separate fees to produce designs in advance.

13.14 The need to pre-order various components and equipment has brought into the design process a large element of procurement. On 'traditional' projects the numbers of suppliers and sub-contractors appointed during the design period, ie before the main contractor, ranged between 2 and 17 and often they were responsible for operations which were critical for progress on site. This complicated the subsequent organisation of work and programming on site.

Buildability

13.15 Recurrent comments made to observers on site during the construction phase also concerned buildability and the suitability of the designs for speedy construction, particularly where the design function had been separated from construction. Study of a random selection of 10 traditionally organised projects, taken from the sample of case studies, found that the designs were not as a rule so simple and straightforward in their shape, lay-out, foundations, mixes of materials and components, positioning of services etc, as to be least difficult to construct. The reason given in discussions was that the changes necessary to facilitate construction would conflict with the requirements of planning or building regulations or the views of customers and institutions about standards of aesthetics, appearance and finish. On several projects, detailing or the choice of materials was impractical: for example non-absorbent bricks were often used in the construction of walls.

13.16 The amount of prescriptive detail that designers should incorporate into the design documentation was an area of some controversy. Contractors' judgement, independence and initiative in carrying out the construction process varied (and was influenced more by relationships than by competence) and so did the number of drawings prepared by the architects. For most projects costing between £100 000 and £1 million between 20 and 30 drawings had been prepared; on some projects there were very few drawings, on others their numbers rose to between 80 and 100. Several architects – who had also practised overseas – left specifications flexible to help speed construction, giving the contractors responsibility for choosing and deciding on details of finish (a part design-and-build arrangement).

14 Aspects of performance during construction

14.1 The case studies have given insights into the workings of 'fast' and 'slow' projects. In the context of fast projects several factors stood out which all centred around the contractor's ability to plan and set a correct pace for the work from the outset and maintain it throughout. This required a clear statement of the design and control over both the supply of resources and the content of the work. The number and competence of his management and supervisory staff were crucial.

Fast projects – quantity and content

14.2 On all 'fast' projects the design documentation – drawings and specifications – gave the contractor a well-defined basis to prepare and provide for the resource needs of the construction project. The flow of information between all parties was timely and well-organised (even pedantic), and the persons responsible for making decisions were clearly identified. Changes in the customers' requirements were small and deviations from the content of the work, as designed, were introduced mainly for operational reasons – obstructions in the ground etc. The customers, or their professionals, were prompt to respond to and take decisions on problems which arose in the course of construction and which could hold up progress. The times within which the customer would respond to queries from the site may have been written into the conditions of contract, but more important was the good rapport which gave the contractor confidence to proceed even after informal consultation and not to lose momentum.

14.3 Fast projects did not necessarily eliminate flexibility in accommodating a reasonable amount of design changes; efficient project teams took 'variations' in their stride.

Fast projects – planning and site management

14.4 Most project arrangements made it possible for the contractor to begin planning and procurement in good time and to take an integrated approach to the organisation of the project, which extended to all specialist sub-contractors and suppliers. Contractors appointed by traditional competitive tenders were at some disadvantage, particularly if they were under pressure to start on site as soon as possible. Given the short preparation time, they had less scope to agree 'best' times with sub-contractors and suppliers who already had multiple commitments elsewhere. Often they built their programme around times specified by sub-contractors.

14.5 The majority of 'fast' contractors in the study relied on their own labour force for most building trades on site. They had high supervision/operative ratios which included specialist services supervisors and they increased the numbers of qualified management and supervisory staff in proportion to the amount of sub-contracted work. The site agents or managers had the qualifications and experience necessary to coordinate the installation of plant and services together with the building work.

Fast projects – programming and resourcing

14.6 Programmes were based on critical path analyses and designed to open up and use work stations at the earliest opportunity. On smaller projects, contractors used flexible multi-disciplinary teams. Progress was monitored closely and the contractor was ready to re-schedule the work, using additional resources if necessary, in order to catch up with minor delays and safeguard the overall target.

Fast projects – design

14.7 The buildings were generally simple, designed with particular attention to ease and speed of construction; alternatively some concessions to buildability had been incorporated during preparation: these concerned mainly interference between trades; sub-division of the work into self-contained packages, concentration of services into particular areas, use of pre-finished components and types of finish which would reduce the congestion of trades towards the end of the project.

Fast projects – control

14.8 The above characteristics were observed on case study projects which had site times 30 to 50 per cent shorter than average and on the very large 'fast' projects. Most were purpose-built and had used design-and-build arrangements, management contracting, integrated design and contract management or in-house site management which gave the contractors (or managers) control over all aspects critical to the progress of the programme. Only two contracts were traditionally organised: in one, the contractor was chosen not on price but on previous performance and on his willingness and confidence to accept the customer's very urgent deadline. In the second case, the customer, after temporarily shelving the project, approached the contractor who had earlier submitted the lowest tender and negotiated a very reduced construction time which guaranteed him completion within the tax year. The contractor was given control over the work and the site; he kept to the original design but raised and re-sited the buildings by 1·2 metres and redesigned the foundations to speed erection of the frame and cladding. He increased site supervision and manning levels to 42 men on site at the peak and put special back-up effort into organising supplies and services on time. Only 2 sub-contractors had been nominated and the contractor largely employed his own operatives. For the customer, the additional cost of reducing the site time from 45 to 28 weeks was £17 000 on a £0·5 million contract. The main components of the on-cost were more expensive foundations, overtime payments to site labour, increased site supervision, the cost of providing for greater concentrations of men and materials on site and some loss of efficiency caused by congestion. At the time, the contractor had a heavy workload overall and a well-stocked order book.

Incentives and the need for speed

14.9 Study of the programmes of a random selection of projects taken from the sample of case studies, showed opportunities for similar savings of site times on a number of contracts. Usually there was scope for more parallel working but the number of work stations had been restricted to allow maximum economy of supervision.

14.10 Programmes proposed by contractors tended to be designed with minimal site supervision in mind. Unless pressed for it, contractors had no good reason to offer shorter site times and increase the management risks and costs of speeded-up working, particularly if they were uncertain about how to provide continuity of work for their own employees. For the same reason they were also wary of recruiting more and better site management and supervisory staff. Projects costing up to £750 000 were usually left in the charge of only one site agent.

Construction time stipulation and targets

14.11 Construction times were most often specified by the customer and his professionals, some were offered by the contractors or agreed after negotiation.

14.12 Construction times distinctly shorter than usual were, without exception, specified by the customer and frequently prompted by the existence of various deadlines which often also involved accurate intermediate timing. The times needed to be realistic and consistent with the contractor's usual system and pace of working, even though he may have also accorded the project particular priority. (Impossible targets were sometimes accepted but rarely seriously attempted.) Because of the high time-related overheads on such projects, it was essential for the contractors to be on site for as short a time as possible to achieve a profit. In this sense they considered the customer's need for speed an operational advantage: the common intent helped good collaboration, prompt decisions and created the right atmosphere for maintaining momentum throughout.

14.13 A considerable proportion of customers, particularly public customers, and also some contractors, were content to plan for very extended construction periods as insurance against delays arising from unforeseen circumstances. The intention was to trade speed for certainty.Invariably, this proved to be a fallacy. In a few cases, contractors worked at their normal pace and finished ahead of agreed durations at about average times, but more often the contracts badly over-ran their planned times: a momentum was never created, the contract had low priority throughout, the knock-on effect of early delays upset the structure of the timetable, interferred with the subsequent attendance of sub-contractors and gradually accumulated into major losses of time. Inevitably, during the prolonged construction period customers' requirements changed (for example demands from new tenants had to be accommodated), causing further complications in the schedule. It did not appear to be in the contractor's best interest to aim for very long construction times: in one £0·5 million advance project, for example, the contractor re-programmed the original 65 week duration half way through the contract to 52 weeks in order not to make a loss, even though this required the injection of more site supervision and back-up effort. (A 'normal' time for the project would have been 39 weeks.)

Speed and costs

14.14 Where contractors were asked for both competitive cost and time, the tender results did not suggest a direct link or trade-off between construction times and cost: often the same tenderer offered the lowest for each. Assuming that offers were 'bona fide' the different offers reflected contractor's varying styles of working and ways of organising the sites with different levels of resource deployment.

Consequences of over-runs

14.15 The form and conditions of contracts alone rarely had any built-in inducements or penalties which would compel the contractor to finish on time; liquidated damages for over-running the contract period could be potentially very expensive but they were not considered a serious threat. Once work had fallen behind, the contractor in several instances felt that the cost of making up any delays would be greater than the penalty that he would have to pay in liquidated damages. The conditions under which many delays arose (for example prolonged waits for authorisation to proceed following customers' variations or other unexpected circumstances) usually made it possible to produce sufficient evidence to justify the additional time and to apportion responsibility equitably between customer and contractor. These arrangements helped also to take the edge off any fear that over-runs might have an adverse effect for the reputations of those involved. On several sites the point which proved critical for subsequent progress arose quite early on, when unforeseen problems in the ground had to be solved. Where the contractor was confident that he would be paid for any initiatives he took, quite informal communications were sufficient for work to continue. On other projects, a 'claims conscious' atmosphere was soon created as time targets continued to slip further away.

General practice

14.16 In one way or another the conditions which produced fast projects – although rarely seen in general practice – were observed also on other efficient contracts with better than average times: sometimes they were all present, perhaps to a lesser degree, on others some were missing and were compensated for by different means. For example a combination of contractor's flexibility and skill, trust born from previous association, commitment and good relationships all round between professionals, suppliers, main and sub-contractors, resulted in several very successful projects which were effectively based on day-to-day decisions only. The contracts and responsibilities had been traditionally organised and no separate co-ordinator was used. Despite the fact that the work included also the simultaneous installation of process plant and that hardly any design had been finalised before starting on site because the customer's production process was still developing, work proceeded well and very ambitious contract times were achieved. However the strain was excessive. Several customers and participants said that they would avoid such an approach in the future.

Reasons for delay

14.17 The general importance for good practice of the factors which contributed to successful projects was also highlighted in reverse when the reasons for delays and slow projects were examined in detail. No construction project, however carefully planned, was immune from unexpected circumstances which could interrupt or hold up progress. The frequency with which particular factors occurred and had been recorded in the site documents of the case studies has been catalogued and is set out below.

Cause of hold-up and delay	Case studies % projects
Sub-contracting	49*
Tenant/client variations	45
Ground problems – water, rock etc	37
Bad weather	27
Materials delivery	25
Sewer/drains obstruction or re-routing	20
Information late	20
Poor site management and supervision	18
Steel strike	16
Statutory undertakers	14
Labour shortage	10
Design complexity	6

14.18 Relating the occurrence of these factors to site time showed that their influence on the total site time varied: some seemed to have little effect, for example ground problems or bad weather occurred on both fast and slow projects. However poor supervision, late information and deliveries, design complexities, difficulties with statutory undertakers and labour shortages were usually associated with construction periods two months or more longer than would be expected, so pinpointing the factors that stand most in the way of a more effective organisation of the construction process.

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* Sub-contracting hold-ups and delays occurred about equally in contracts with both nominated and domestic sub-contractors and were often also associated with other factors. For example, on some 10 per cent of the projects earlier delays had necessitated changes in the programme and sub-contractors were unable to accommodate the revised schedules, the use of sub-sub-contractors led to similar delays on 6 per cent of projects, ineffective project supervision affected 8 per cent of projects, etc.

15 Discussion

15.1 There is little 'hard' information which would help to put the time-keeping and pace of industrial projects – as found in the study – into a wider context. Evidence from the US appears to show that industrial building times in the UK are nearer those in the US than in any other building sector. Within the UK, industrial building projects are also relatively faster than, for example, projects in the commercial sector where influences on project times are more diverse and complex. Comparisons with earlier studies of industrial and other types of building made in times of construction 'boom' show no acceleration in the general pace of construction in recent years. There may now be greater readiness to overlap pre-construction activities and there are also fewer delays due to materials' deliveries, although the wide spread of project times masks this effect. The clearest indication comes from the data themselves. If, in generally similar conditions, projects have a significant chance of taking either half or double the average time then there is a genuine case for considering whether and how the norm could come nearer the best achievements.

15.2 The study has shown that, by and large, construction is as fast as customers can exact from the industry. Rarely did technical or physical constraints pose limitations. In the absence of any generally accepted times for given types of project the onus for requesting 'fast' times is left to the customers. Next to the traditional competitive method, customers can obtain their buildings and also use the services of the industry in various other ways. Few customers have the know-how and experience to demand 'fast' times, to make informed choices about the organisation of their projects and to commission it in a way that assures them of all their requirements.

15.3 Customers are not a homogeneous organised group and thus are not in a position to apply uniform standards, particularly as there are no easily accessible sources of objective and practical information which could guide their expectations and moves. As things are, inexperienced customers are potentially at a disadvantage because they have no certainty of getting maximum service from the industry every time.

15.4 The research has not found evidence that speedier projects necessarily carried for the customers penalties in terms of extra costs, loss of flexibility or quality. Neither were customers ever intentionally unconcerned about the speed or pace of their projects.

15.5 The enquiries have highlighted both 'good practice' and the factors which can interfere with the speedy and effective progress of projects. They concern methods of organising projects, various aspects of performance in design, procurement and construction management, as well as loss of control over the supply of construction manpower. Most are within the province of the participants in the building process.

15.6 Fast projects require:

- customers with knowledge of what is achievable and requiring a short time, accurately specified by dates or deadlines
- customers well-advised about the workings of the method of contract organisation and about the building team they choose
- coherent management responsibility for the progress of the project throughout
- overlapping pre-construction activities
- project arrangements which allow early, precise and integrated procurement and preparation for construction
- a clear statement of design which takes into account practical aspects of organising work on site
- competent and adequate site management and supervision
- control over site labour resources
- good communications and incentive to complete on time.

15.7 The body of evidence from the research confirms and quantifies many of the opinions expressed by the industry. It provides a starting point for discussion on actions within the industry.

Part III Case studies

16 Introduction and summary tables

16.1 In the course of the research detailed studies were made of a sample of 56 recently completed industrial projects. The projects were selected to be representative of industrial construction in type, size and regional distribution. They reflect a wide range of performance as well as the different methods and arrangements used in the procurement of new industrial building space.

16.2 The studies have covered the entire case history of each project – from inception to completion on site – and were based on interviews with all principal parties to the project – customers, tenants, all consultants, contractors, as well as on information extracted from project documents – contracts, drawings, bills of quantities, site minutes, programmes etc. Data about the projects in ascending order of their contract values are summarised in the tables

- purpose-built projects in Table 16.1
- advance projects in Table 16.2.

16.3 A brief and informal summary of the history of each project was prepared each time. A selection of these have been reproduced here with a view to presenting a more comprehensive picture of the information collected for this part of the research.

The heading on each summary gives:

- the project number
- the type of project: purpose-built or advance
- contract value in £000s at 1980 prices
- floor area m^2
- the method of contract organisation
- customer experience: either continuous building programme, experience of previous projects or first-time building experience
- site and total project times and the difference from average times for contracts of similar size.

Note: The summaries should be read in conjunction with the respective project details in Tables 16.1 and 16.2. The projects are marked with an asterisk. The summary of one special study has also been included; for reference see also Appendix A – 'The Structure and Scope of the Research'.

Table 16.1 Summary – purpose-builts projects

					Times, months						Sizes and types of		
Project No.	Contract value, £000s, (1980 prices)	£/m²	Location	Description	Pre-construction	Planned construction	Actual construction	Over-run	Total time	Contracting method	Client	Architect	Contractor
P.1 → P.1	25	133	West Midlands	Workshop with 20% office area (load bearing brick)	20	n.a.	6.5	n.a.	26.5	Own management, negotiated, part self-build	Small	Small	Small local
P.2	83	146	East Anglia	Factory, 14% office area	8	7	7.5	0.5	15.5	Design and build, competitive	By local authority for small firm	Local authority specification. Independent architect employed by contractor	Medium-sized l
P.3	99	127	Scotland	New factory, 12% offices, system built	32.5	5	5	0	37.5	Own management, competitive	Metal fabricators, established 7 years	Design by engineering consultant recommended by accountant	Let as 7 package including buildi system for struc
*P.4	106	211	South-east	Laboratory type production unit, 16% offices	4.5	n.a.	5	n.a	9.5	Own management, competitive	A high technology firm established 12 years	Recommended by local authority – designed for ease of building	Let as 11 packag to local firms
P.5	114	137	North Yorkshire	Animal food processing plant, system built	5	6.5	6.5	0	11.5	Design and build, negotiated	Small firm	Design service only	Medium sized l firm experience industrial work
P.6	118	332	North-east	Extension to an existing building	23	5	5	0	28	Traditional competitive	Large electronics firm	Tight specification and part of design by client's architect's department, some work by local architect	Medium sized l firm, turnover £
P.7	130	221	Scotland	Extension to an existing factory, system built	5	5	3.5	−1.5	8.5	Design and build, negotiated	Clothing manufacturer	Technician employed by contractor	Specialist in industrial work, been used for t existing buildin
P.8	187	134	North-east	Factory extension with laboratory and offices, 19%; system built	7	3.5	3	−0.5	10	Design and build, negotiated	Small, expanding firm with wide experience of the construction industry	Design by system firm	Medium-sized round firm, use previously. Mo trades directly employed
P.9	200	256	Yorkshire	Rebuild and extension after fire. Two separate phases	2	9	9	0	11	Traditional competitive	Small printing firm	Small old established architect, used before	Medium-sized l contractor. Mo work sub- contracted
P.10	271	232	North-west	Canteen refurbishment	8	3.5	3.5	0	11.5	Design and build, negotiated	Very large	Client's outline, contractor's architect	National
*P.11	412	227	Yorkshire	Factory, 4% offices	4.5	7	5.5	−1.5	10	Management contracting negotiated, contractors competitive	By local authority for expanding firm	Local authority architect	Management contractor Nati
P.12	415	245	South-east	Factory extension with 16% offices and 9% laboratories, system built	12	12	12.5	0.5	24.5	Traditional negotiated	Small company pioneering a new process	Local architect	Old established medium-sized l firm. Used previously for existing buildin
P.13	494	148	East Midlands	Warehouse linked, 2-storey office block 19%	14	8.5	9	0.5	23	Design and build, negotiated	Small	Design by contractor. Client's architect checked it	Regional, fairly large
*P.14	530	127	Midlands	Warehouse, 10% offices	21	9	11.5	2.5	32.5	Project management, competitive	Large building material distributor	Multi-discipline consulting firm, used before	Medium-sized company, their project in this a

Type of ground	Construction timing	Delays, etc	Assessment
Re-used	Clients decided to manage and part self-build after finding estimates too dear.	Site problems – drains on local authority estate not in position shown, and deeper. Architect would like a check list to help anticipate difficulties on re-used land. Statutory undertakers a problem – did not meet dates given.	The client was happy with the method used and will repeat for an extension. Rate of progress slow, dictated by self-build and manage element.
Greenfield	Time decided by local authority – the contractor thought it could have been shorter.	Over-run 2 weeks on landscaping due to slow sub-contractor. A tight local authority specification did not allow scope for the design and build contractor for speed or convenience.	A tenant was waiting for the factory and a faster time should have been achieved. Possible advantages of design and build not exploited.
Greenfield, needing drainage	The long pre-construction time covered tendering at the end of 1979, simplification of the design to reduce costs and re-tendering in 1980, and finally the decision by the client to manage the work himself.	Problems with waterlogged ground and connection of land drains. Further delays due to mistakes in ordering materials. Some problems with sub-contractors but work nevertheless speeded up to finish on time.	The client was satisfied that he had reduced the price by managing himself. Some of the contractors were less pleased, missing the help and discipline provided by a main contractor. An average construction time.
Re-used, sloping, in residential area	Estimates from local contractors were about double the final cost achieved by client management.	Some delays in delivery of materials and a dispute with scaffolders, otherwise no problems.	The enthusiasm and organisational ability of the client gave a successful result – average time and low cost.
Greenfield	Timing dictated by the client who wanted completion to obtain a government grant.	Some minor variation and slow information from equipment suppliers.	The basic system used allows workers to become familiar with the components. Flexible work force gives continuous working. Time slower than average.
Re-used	Contract period requested by client – the contractor's programme was for 2 weeks less, which covered the delays.	Groundwork delayed by client changes. Steel floor finishes and windows late on site: brickwork slow due to types of brick chosen. Complication of join to existing building necessitated return visit of steel and cladding trades.	An experienced client, a rigid brief, a flexible local contractor and architect ensured a successful completion. An average time for a more complex than average project.
New ground	Client required speed as premises elsewhere had been destroyed by fire and had to be rapidly replaced by this extension.	An unmapped sewer was found during excavation. Some client changes which were easily absorbed. Bricklayer shortage.	Good relationship between client and contractor from previous work and flexibility of the workforce gave speedy completion. Time 2 months faster than average.
Poor load bearing	Client required rapid completion to qualify for a development grant.	Extra foundations were found to be necessary, rapid approval of extra cost from client. Smaller contractor used for office finishes.	A very fast job completed in half the average time. The client's urgency, his experience of the industry, and the contractor used all contributed to a successful project.
Re-used, awkward shape	Following a fire the client was anxious to restart production. The first unit was required quickly to house machinery. Approximate bills used for speed.	Obstructions and industrial waste in the ground delayed the start. Problems on the second phase – lack of space, and client changes with conflicting instructions producing friction.	The slow overall time was mainly due to a break between the two phases. The use of approximate bills of quantities (with subsequent re-measure) contributed to a speedy start.
Refurbished	Client required a fast time as workers were without canteen facilities while the job was in progress. Negotiated tender for speed.	Day to day decision-making quickly speeded progress. Finished on time in spite of late completion by some sub-contractors.	Client very satisfied. Contractor liked negotiated contract – allows proposals for speed to be incorporated.
Re-used	Speed dictated by tenant's requirements. Negotiated management contract for speed, enabled project to go ahead before design details complete.	Re-used ground, partly waterlogged, had to be pumped out and filled. 2 weeks extra work for tenant changes, but completion ahead of schedule.	National contractor for management helps, eg. in chasing suppliers. A fast job completed ahead of schedule, helped by co-operative attitude of all parties, with rapid resolution of problems.
Adjacent to existing soft spots	An early start was required although the process had not been finalized. The contractor used was asked to price an approximate bill, using the same building system as before.	A patch of soft ground caused initial delay. Development of the process as work proceeded resulted in a large number of alterations but most work completed to programme.	The good relationship between the client and contractor was essential for dealing with the many variations. The complexity resulted in a slow time.
Made-up	Time decided by contractor. Deliveries of critical materials highlighted on programme.	Tendency of ground to become waterlogged. Delays by statutory undertakers; sewers and gas. Steel strike caused most of the 3 week over-run. Painters chosen for cheapness did not appear when required. Some client changes in priorities caused inconvenience.	Average site time; the client was very pleased.
Ex-colliery site	The project manager works regularly for the client. Contractor chosen on time offered rather than price.	Sewer location wrongly given by the authority, re-routing delay. Industrial action delayed steel and cladding. Material supply problems. Bricklaying and bricks not adequate for the design and work re-done. Statutory undertakers delayed completion.	Slow time with 2½ months delays, the contractor being new to the area was not able to get good sub-contractors and the site agent was inexperienced.

Table 16.1 Summary – purpose-built projects (continued)

					Times, months						Sizes and types of		
Project No.	Contract value, £000s, (1980 prices)	£/m²	Location	Description	Pre-construction	Planned construction	Actual construction	Over-run	Total time	Contracting method	Client	Architect	Contractor
*P.15	563	202	North-west	Factory unit, 20% offices, canteen etc.	9	6	6.5	0.5	15.5	Design and build, competitive	Diverse industrial group with £4m building programme	Client's architects did preliminary drawings. Contractor employed a small practice	Small firm, turnov £1.25m, mostly industrial and housing
P.16	583	139	South Wales	Warehouse 7% offices (pre-cast concrete frame)	9	7* 5⁺	8	1* 3⁺	17	By developer for client, main contractor negotiated	Large firm	Medium size	Regional, fairly large
P.17	700	163	South-east	Three advance units combined and modified for a particular tenant	12	12	12.5	0.5	24.5	Traditional, competitive	Local authority with industrial building programme	Experienced local authority architect	Old established firm working regularly for the authority. £3m turnover.
P.18	703	504	South-east	Laboratory and offices, 50%. Part 2 storey	21	12	12	0	33	Design and build by developer for client, negotiated	Large specialist firm	Outside architect employed by developer	Developer sub-contracted to known firms
*P.19	704	210	North-west	Factory, warehouse and offices, 26%	13	9	10	1	23	Design and build, competitive	A foreign company renting a nearby factory building for first time in UK	Outside architect retained by contractor	National contract experienced in thi type of project
P.20	793	176	Wales	New production unit and alterations to existing unit	21	11	12.5	1.5	33.5	Traditional, competitive	A public development agency for a particular tenant	Large practice with 40 staff	Large national specialising in civi engineering work
P.21	866	250	West Midlands	Steel rolling mill, 8% offices	21	12	11	−1	32	Traditional	Steel manufacturer	Medium size	National
P.22	897	754	South-west	Laboratory extension	9	14.5	14.5	0	23.5	Traditional, competitive	Large international company with a continuing building programme	Large practice with a number of branches chosen after interviews with 6 practices	Small national contractor, turnov £40m. Interviewe by client to assess capability
*P.23	1227	171	North-west	Factory extension	3.5	6	6	0	9.5	Traditional, tendering on approximate bill	Large engineering firm	Large multi-discipline practice	Large regional
P.24	1230	266	North-west	Warehouse and conveyor link	7	8	12	4	19	Traditional	Textile company – subsidiary of large firm	Small	Medium-sized Midlands firm
P.25	1306	413	Scotland	Warehouse and packaging; offices & 18% canteen	18	14	12.5	−1.5	30.5	Project management negotiated; contractors competitive	Medical products, subsidiary of overseas company	Large, responsible to project manager	Large project manager National contractor
P.26	1358	242	East Midlands	Factory and 2 storey labs and offices, 25%	17	9	10	1	27	Traditional	Large electronics firm	Fairly large	Large regional
*P.27	1507	279	Midlands	New production unit and offices, 20%	4	9	9	0	13	Project management, competitive	Food manufacturer	Consultants used regularly by the project manager	Large national contractor. All wor sub-contract

* original planned times
⁺ revised planned times

Type of ground	Construction timing	Delays, etc	Assessment
Sloping mine workings causing subsidence	Client produced detailed specifications and obtained preliminary drawings and cost estimate. Tenders from 3 contractors – choice made on contract period and evidence of design skills.	Site dimensions were not as expected, necessitating movement of the building and adding a retaining wall. Minor materials problems. Client variations involved some extra work which accounted for the 2 week delay.	Client satisfied with this first venture into design and build, and finds it cheaper. Contractor modified the design for ease of building and maintained fast progress giving a time 3 months less than average.
Re-used	The original planned time was 7 months. At the client's request the job was reprogrammed to take 5 months.	Actual time 8 months. Site problems: waterlogged and a labyrinth of un-mapped drains, other obstructions. Slow local authority response on problems. Concreting difficulties, some work had to be re-done. Labour-only bricklayer had to be replaced. Door delivery bad.	The actual time was below average, although considerably longer than planned. Site problems, weather and sub-contractor difficulties caused delays. Design not conducive to speed according to contractor.
Sloping farmland – some rock and old buildings	Start delayed 2 months for tenant modifications. Handover date agreed with tenant.	Inaccurate information from the authorities necessitated redesign of the drainage system. Delays due to cladders' late arrival and poor workmanship. Many tenant amendments throughout.	Handover was on the agreed date, but with external work still continuing. The time was over 2 months slower than average.
Greenfield	A time was decided by the developer/contractor, but after client's delay in signing agreement caused a late start it was shortened.	Client's indecision delayed work at floor slab stage. Ventilation sub-contractor on site 9 weeks later than planned. Delay on roof completion due to exceptionally bad weather. Completion nevertheless on time due to efficiency of developer/contractor.	A complex job, not normal industrial. Hence above-average construction time. The only sub-contractor nominated by the client (ventilation) caused delay, made up by developer.
Made-up ground	The client investigated various possibilities for about a year before deciding – the need for the building was then urgent and a short time was set.	All the work was sub-contracted, some causing delays due to insufficient control by the site agent. Bad weather hold-up was overcome by over-time working. Many client variations resulted in delays.	The final time was average. With fewer client changes and better control of sub-contractors, the time would have been shorter.
Previously compacted. Some rock	The tenant was slow making decisions on his requirements, which held up the architect. Nevertheless he hoped for an early completion.	Delays due to bad weather; rock in ground which had not been detected by trial holes; industrial action; bad workmanship; services contractor late and alteration work slower than expected.	A slow time partly due to site agent's inexperience in dealing with co-ordination of the many sub-contractors.
Old mine working	The client would have liked an earlier completion but chose the tenderer giving the lowest price, (one offering 9 months cost 10% more) and known for his reliabilty.	The steel contractor chosen for cheapness could not supply on time. Client changes necessitated foundation alterations. Contractor overcame these problems to finish ahead of programme.	2-month delay in starting due to local authority changing site boundaries. The contract finished ahead of schedule with a time about average.
Adjacent to existing buildings	The period offered by the contractor was considered reasonable.	The client finalized the drawings before the start and only minor variations occurred. Services sub-contractors were chosen on client's previous experience. Material supervision through a clerk of works and a project manager.	Slower than average site time, but, as shown by the high cost per unit, a much more complex job than normal industrial work. The client's experience, careful choice of participants and good supervision gave completion on time and within budget.
Re-used	The client specified the short time period, necessary to qualify for a grant. Some design work for an earlier scheme used, detail drawings produced during construction.	Recycled ground requiring piling. No proper record of sewers and a problem with a culvert was not resolved until 2½ months after the start. The local authority was slow to respond on a problem with an HT cable which had to be diverted. Steel delivery delay, also fencing materials. High winds disrupted cladding.	A very fast job, co-operation all round to meet client's deadline. A basic shell with little finishing works. Completion 5 months faster than purpose-built average.
Re-used	Client debate on costs delayed start by 2 months.	4-month over-run. 7-week extension allowed by architect, submerged obstructions in ground – 5 weeks. Late design information delayed steel delivery. Labour problems, contractor outside his area. Weather affected cladding. Roofers and duct workers also a problem.	Actual time not much above average, but 4 months longer than planned due to various problems.
Mine infill	Time originally planned 12 months, changed to 14 because of steel strike.	Delays due to diversion of existing services, waits for information from services sub-contractors, cladding-materials and weather. Nevertheless, completion ahead of schedule.	A complex project with large services element. Actual duration about 2 months longer than average.
Old quarry spoil filled	Short planned time for a job of this size.	3 week over-run due to additional work, poor performance by some sub-contractors, steel strike.	In spite of the over-run the actual time was faster than average. The client was extremely pleased.
Made-up ground requiring piling	After a preliminary design proved too expensive the project manager was approached and a deadline of 12 weeks given for possession. Discussions with contractor held to decide on best time and cost construction.	There were some difficulties with sub-sub-contractors for cladding and electrical work and a number of client changes and statutory requirements affecting mainly the services. Nevertheless completion was on time.	There was close co-operation between the project manager, consultants and contractors with high calibre supervision which overcame problems.

Table 16.1 Summary – purpose-built projects (continued)

					Times, months						Sizes and types of		
Project No.	Contract value, £000s, (1980 prices)	£/m²	Location	Description	Pre-construction	Planned construction	Actual construction	Over-run	Total time	Contracting method	Client	Architect	Contractor
P.28	1683	302	South	Production and office unit – high level of services and cleanliness	6	12	11	−1	17	Design and build, competitive	Subsidiary of international company, manufacturing pharmaceutical products	Contractors own architect's department	Subsidiary of a large developer. Concentrates on design and build and housing.
P.29	1935	75	North-east	4 factory units and amenity block, 3%	1	6	12	6	13	Management contracting negotiated; contractors negotiated	Large kitchen manufacturer	Medium	Medium-size project manager
* P.30	2180	240	South-east	Production unit, 13% offices and laboratories	9.5	12	28	16	37.5	Traditional, competitive	Company planning expansion for 2 years	Recommended by estate agent, not local	Large regional, turnover £29m. Mainly public and commercial work
P.31	2333	774	Scotland	Factory and offices 17%, separate boiler house	9	16	17	1	26	Design and build, negotiated	Large company in food industry with continuous building programme	Contractor's own design group	Design and build specialist used on many previous jo
P.32	2259	416	South-west	Specialist warehouse	6	9	12.5	3.5	18.5	Project management, competitive	Transport subsidiary of a large manufacturing group	Large local practice	Local contractor with mainly direc employed labour
* P.33	3400	252	Wales	Factory extension and staff facilities block	8	12	18.5	6.5	26.5	Traditional, competitive	Public development agency for overseas company's first development here.	Large practice with several offices	National, civil engineering practice
* P.34	2900	449	Wales	Electronics factory	9	13	12	−1	21	Design and build	Large overseas company	Branch of contracting firm	Industrial and commercial package specialist
P.35	11,950	378	North-east	Electronics factory	10	16	17	1	27	* Design and build, negotiated	Expanding electronics company	Regular architect	Medium-sized contractor developer

Type of ground	Construction timing	Delays, etc	Assessment
New ground containing two ponds	Quotations from 3 contractors on a 2-part-shell and fitting-out basis. Choice on management standard and reputation as well as cost.	Groundworks delayed by bad weather (separate contract by contractor's subsidiary). All other work sub-contractors, mostly to firms used regularly. Some delays due to lack of information from the client or his plant suppliers but finish on time.	A successful outcome due to co-operation between client's representative and the contract manager. The service work was felt to be too costly and poorly supervised. A faster than average time.
Greenfield	A fast time was set by the client. Then his market dropped and there was no longer urgency.	Client changes caused much of the over-run. Additional height required in 1 unit, but steel strike prevented delivery of extra material required.	The final time was below average although double that originally planned.
Sloping, former market garden	The client specified 10 months for the factory and 12 months for the office block.	Slow progress from the start: labour shortage, information slow coming from architect, poor performance by sub-contractors, bad weather, insufficient supervision. There were 15 nominated sub-contractors, 17 domestic sub-contractors and also some labour only.	Factory 9 months late, offices 14 months late. Main causes – inexperienced, distant architect, insufficient supervision by main contractor of the many sub-contractors.
Exposed, gravel pit	Period requested by the client.	Wind on the exposed site caused cladding delays. Client's amendments accounted for the 1 month over-run. Client's direct contractors caused delays.	A proficient design and build contractor with long previous experience with the client gave a smooth running project.
Part greenfield, part made-up needing completion	9-month period requested by the client was exceptionally short for such a large project.	Lack of information from the client's direct contractors and a last minute re-design of the office block caused delays.	A faster than average project although the short target was not met. The contractor was well organised and able to handle variations as they occurred.
Re-used	Client's tenant asked for an early completion. Separate site preparation contract.	Labour dispute, variations, sub-contractor problems, ineffective supervision all caused delays.	Communication difficulties due to tenant's inexperience in this country and the need to pass information through the development agency. The main contractor's inexperience of this type of job led to difficulties and delays. Most work sub-contracted.
Re-used, obstructions	Client/contractor project team agreed a time. Contractor visited parent factories.	Client variations incorporated without problems.	Good motivation and cooperation between client and contractor gave a fast time.
Greenfield, extra costs to deal with flooding and overhead power cables	Early start achieved by using separate contracts for shell and fitting out. Sub-contractors chosen for speed. Services concentrated for ease of construction.	Some delays due to snow and high winds, but not critical.	A fast time for such a large project. Use of contractor's own labour, and sub-contractors chosen for speed contributed. The client took responsibility for the services work.

Table 16.2 Summary – advance projects

					Times, months						Sizes and types of		
Project No.	Contract value, £000s, (1980 prices)	£/m²	Location	Description	Pre-construction	Planned construction	Actual construction	Over-run	Total time	Contracting method	Client	Architect	Contractor
A.1	90	134	North-west	2 units in 1 block, 9% offices	12	7	12	5	24	Design and build competitive	Local authority	Contractor employed separate architect	Small, newly established firm
A.2	96	178	Scotland	5 units in one building, system built. Excludes groundwork	13.5	4.8	4.8	0	18	Design and build, competitive	District council	Outline drawings by local authority architect, details by contractor	Medium sized loca contractor specialising in design and build using system
A.3	229	143	Scotland	2 warehouse unit, 3% offices	12	6.5	7	0.5	19	Traditional, competitive	Predominantly a housing developer and builder, but 6 year expertise of industrial and commercial work	Used before – design for proposed projects but only paid if they are built	Old established regional firm; mainly industrial, commercial and public non-housin
A.4	245	124	West Midlands	One building divisible into 3 industrial/warehouse units, 17% offices	5.5	6.5	6.8	0.3	12.3	Project management, contracting competitive	Developer with previous experience of project manager and consultant used	Multi-disciplined practice experienced in development work	Medium-sized regional, turnove £10m. Mainly industrial and commercial.
A.5	389	143	South-west	3 units in 1 block, 12% 2-storey offices	17	12	10	−2	27	Traditional, tendering on specifications and drawings	First development by industrialist with spare land	Small local firm	Local – fairly smal
A.6	407	239	Yorkshire	21 units in 2 blocks: 1 single storey, 1 two storey, 4% offices	15	11.5	17	5	32	Traditional, competitive	Large local authority with programme of industrial developments	Local authority architect	Local authority direct works department
* A.7	427	135	South-west	12 units in 1 block, 9% offices	8	9	9	0	17	Traditional, tendering on specification and drawings	Large specialist developer	Large – 5 offices, used regularly	National (no local base)
* A.8	507	203	West Midlands	12 nursery units in 2 blocks, 3% offices	19	5.5	6	0.5	25	Traditional, competitive then negotiated	Retailer recently going into development, limited experience	Medium sized – used before	Medium-sized Midlands firm
A.9	510	148	South-east	8 units in 3 blocks, 2 for specific tenants, 11% offices	11.5	15	12	−3	23.5	Design and build, negotiated	Local authority with continuous development on this site	Architect linked to contracting firm	Local firm had be used previously the site. This proj larger than any previous
A.10	526	153	South-west	6 units in 2 blocks, 2-storey offices	8	9.2	8.7	−0.5	17	Traditional	House-building specialists, recently also doing industrial developments	Medium-sized local, came with site	Local family firm
A.11	555	113	East Anglia	11 units in 2 blocks, 12% offices	7	12	13	1	20	Design and build, negotiated	Medium-sized specialist developer	Contractor's architect	Medium-sized regional, used regularly
A.12	654	212	London	4 units in 1 block, 10% 2-storey offices (pre-cast concrete frame)	8	9	12	3	20	Traditional, negotiated	Manufacturer developing surplus site	Small – used previously	Medium-sized, contributed to design details
A.13	703	198	South-east	20 mini-units in 3 blocks, 3% offices	7.5	6	7	1	14.5	Own management, structures package competitive	Local developer established 2 years	Local – used regularly	National speciali for package deali structure

Type of ground	Construction timing	Delays, etc	Assessment
Made-up	The council wanted completion in 7 months to qualify for a grant.	5 month over-run due to: 1) Extra work for prospective tenant, costing £8.3k. 2) Steel sub-contractor 1 month late, cladding 3 months late–materials problem.	An inexperienced contractor, would choose sub-contractors more carefully in future (had been governed by price). Extra work for tenant caused delay. Client satisfied.
Cleared slag heap, no problems	6-month gap between tender acceptance and start while contractor obtained approvals, then steel strike delay.	Slow start due to effects of steel strike, otherwise smooth progress. Few amendments.	A simple straightforward contract with no problems, but the local authority architect will in future prefer traditional construction.
Inner city Part re-used, part made-up; sloping and awkward shape	Tenderers offered periods varying from 28 to 40 weeks. The successful contractor offered both the shortest time and lowest price.	Initial delay of 1 week due to site conditions, digging trial pits to examine existing retaining walls. Further delays due to cladding delivery and weather. Also sewer connection problems and tenant negotiations.	Co-operation of client and consultant and skill of contractors overcame problems typical of inner-city sites to give average construction period.
Ex-colliery site requiring vibro-compaction	6 contractors, mostly local, offered periods between 29 and 26 weeks. The successful tenderer offered the shortest time and the lowest price.	The start was in October, and bad weather soon caused delays, mainly to cladding. The bankruptcy of a plasterer delayed following trades. There were some alterations causing 1 week delay, nevertheless completion was nearly on time.	The main contractor, well established in the area, was able to overcome problems due to direct employment of key workers and connections with regular sub-contractors. There was also a good site agent.
Made-up	Contractor wanted 13-month period because of site complexity and degree of finish. Client wanted greater speed–doubling up on finishing trades' contractors completed in 10 months.	River-bed site made up for previous use, some piling needed and obstructions found. The architect was not satisfied that the site agent was maintaining good progress and had him replaced.	Planning difficulties caused pre-tender delay. Site time, though shorter than originally planned, was above average.
Inner city, re-used mine working beneath	The local authority specified 50 weeks.	Gas strike–3 weeks; cladding fire–2 weeks; weather–3 weeks; tenant change–1 week. Poor supervision resulted in poor performance by both direct labour and sub-contractors with additional delays.	Planned site time 3 months longer than average. Delays of 5 months gave final time double the average. Inexperienced management was a major factor.
Greenfield	The architect made the specification flexible and the design simple for speed.	The distance from the contractor's base caused some difficulties, the developer and architect were not satisfied with the supervision. Local sub-contractors were chosen for cheapness and cladders and groundworkers were poor.	Programme met in spite of sub-contractor difficulties. With better cladders contractor maintained completion could have been 3 months earlier. Actual time about average.
Re-used	A period of 10 months initially planned by the professionals. The client after pre-contract delays, wanted this halved, for tax reasons. The contractor co-operated, changing features of the design for speed.	The client's demand for a pre-finish opening ceremony led to the short delay.	Indecision by inexperienced developer caused long pre-site time. An efficient contractor's co-operation gave a short site time, the only advance case study with a time below the purpose-built average.
Former aerodrome. Special drainage required	Phased completions required: 34 weeks for 2 'bespoke' units, 65 weeks overall. A generous total time resulting in lack of urgency at the start.	Variations to satisfy prospective tenants led to abortive work and delays from the start. At week 27 a new director of the contractor speeded the work by pressing for information, improving supervision and replacing some sub-contractors.	The time achieved, though faster than planned, was 3 months longer than the average. The client in future would build to a firm specification and not let units until completed.
Methane pollution	Time specified by client, contractor thought it could have been 1 month shorter.	Ground problems: methane pollution and need for compaction which took 6 weeks longer than expected. Delay in brick deliveries, extra gang put on to catch up. Cladder and roofer slower than programmed, but cheap.	A smooth-running job with a finish ahead of schedule. Variations kept to a minimum. Time below advance average. Some design and approvals before developer took over.
Re-used	Time decided by contractor taking into account the amount of site works and an impending steel strike. Client would have liked shorter period but values more a contractor who keeps to time and price.	One month over-run caused by steel trike, difficulty in getting cladding.	A long previous association between developer and contractor and a job similar to previous ones. Nevertheless a slow time.
Re-used	Time suggested by contractor and considered reasonable by client, finds pressing for short times leads to excuses for delays and extra charges.	Three month over-run caused by extras for prospective tenant and associated delays. Two units were combined: cost £30k.	The contractor had the last say on design details although drawings were produced by a separate architect. Planned time below average for advance.
Adjoins flood plain increased cost for piling and beams	A very short time set by the developer, made aware of a demand from investors wishing to take advantage of tax allowances available.	The piling contractor worked through Xmas to catch up after a machinery breakdown. After bad weather delays a 12-hour day was worked for 4 weeks to meet target. Finally the only delay was due to statutory undertakers: gas and water.	The developer's own contract manager achieved a fast time, 3 months less than the average, by strong control of package contractor and by good rapport with other sub-contractors.

Table 16.2 Summary – advance projects (continued)

					Times, months						Sizes and types of		
Project No.	Contract value, £000s, (1980 prices)	£/m²	Location	Description	Pre-construction	Planned construction	Actual construction	Over-run	Total time	Contracting method	Client	Architect	Contractor
A.14	893	223	London	Conversion of 5 storey to give 20 units	13	9	11	2	24	Traditional, in-house architect	Bank with large building dept., project part of package with local authority to get land for own use	Bank's own architect	Large regional
A.15	977	137	South-east	8 units in 3 blocks, 7% offices	10	10	13	3	23	Developer and contractor same company	Group of companies in construction operations here and overseas	Small firm, came with project	Developer's own firm
A.16	1060	160	Scotland	11 units in 2 blocks, 2% offices	13	9	11	2	24	Traditional	Insurance company with large development programme	Large local, first time used	National
A.17	1159	209	London	10 units in 1 block, 17% 2-storey offices	7.5	9.5	14	4.5	21.5	Traditional tendering on approximate bill	Medium-size specialist developer	Small, used before	Medium-sized regional
A.18	1425	225	South-east	19 nursery units in 3 blocks, 8% offices	5	12	13	1	18	Project management negotiated	Developer initiated the project, then acted as project manager for funds	Large practice, working regularly for the developer	Associate compa of developer, £23 turnover
A.19	2150	180	South-east	13 units in 5 blocks, 10% 2-storey offices and refurbishment of 3 units	14	14	18	4	32	Design and build negotiated	Large property company	Large, employed by contractor	National, previously used
A.20	2700	252	South-east	20 units in 5 blocks, 20% 2-storey offices	13	12.5	13.5	1	26.5	Design and build, negotiated	Developer/contractor partnership	Industrial specialists, retained by dev.	National
A.21	3500	174	South-east	20 units in 5 blocks, 9% offices	11	13.5	15	1.5	26	Project management, competitive contracting	Insurance company	Large, previously used by client	Medium sized, development experience

Type of ground	Construction timing	Delays, etc	Assessment
Conversion	Time decided by contractor, not critical for client. Start delayed 4 months by contractor's heavy work-load. Client insisted on critical path programming.	Conversion of existing building, considerable site restrictions. District surveyor's requirement for more extensive footings and cladding cost £30k extra and added 6 weeks. Flooding caused 2 week delay, cost £5k.	Client satisfied. Planned time below purpose-built average but, due to delays, actual just above.
Greenfield	Time decided by contractor, the developer would have liked a shorter period. Although part of the same firm, operate independently.	Late nomination of steel erector delayed the start, 5 weeks extension granted. Steel strike: structural steel arrived 2 weeks late, cladding had to be imported. Design changes: extra partitioning and electrical work, 2 weeks. Due to late placing of order 2 months delay in completion through wait for gas supply.	Difficulties due to a rushed start with preparation and pre-ordering not properly completed. The developer was not entirely satisfied with the architect, taken on from previous developer, likes to work with a familiar team 'Architect must be strong to outwit contractor.'
Re-used	Planned time regarded as standard.	Re-used land caused problems, soft spots dealt with over a 4 month period, requiring frequent meetings of professionals. Cost extra £100k. Also groundworks problems due to weather and changes in road levels required by local authority. 2-month extension granted.	Client very pleased with the end product but would have liked an earlier completion. Finds prices high in Scotland. Actual time quite low for advance. Efficient site agent.
Re-used	Planned time decided after discussion between client and professionals, a shorter time would be desirable, but developer never sacrifices design for speed.	Unpredictable ground next to canal; foundations took 13 weeks. Main part of 4½ month delay due to main contractor: poor site agent, failure to order bricks, labour note available when required. Failed to realise the complexity of the job, design rather special.	Pitfalls of accepting a low bid demonstrated: long delays and in the end the final price was up 24% on the tender.
Re-used, peaty, vibro consolidation used	Time negotiated with contractor. Reduced from 56 to 52 weeks by using all metal cladding and eliminating external tarmac.	Groundworks delayed by waterlogged soil. One week delay by steel erectors through plumbing difficulties. Exceptionally bad weather main cause of delay.	The team of developer, architect, engineer and contractor, by working together regularly, had developed a basis for solving problems on and off site. An average time.
Re-used	Developer considered the planned time realistic.	4-month over-run. Re-used ex-industrial land caused problems. Sewers and drains needed diversion. Unforeseen difficulties necessitated expensive site fill, cost £100k extra. Extra work for tenants. Gas delay.	Problems of material deliveries etc. Could have been overcome at a cost but the client did not consider that the demand justified it.
Re-used, soft spots	Programmed to a tight schedule as tenants were waiting.	Soft spots necessitated re-design of some foundations. Alterations also to satisfy building and fire officers. Some sub-contractor and material difficulties. Delay due to heavy snow.	A high standard of site supervision overcame the problems and 2 blocks finished on time. Sound problem and bad weather the main causes of one month over-run.
Made-up, requiring piling	Contractors tendering asked to specify a time. Successful firm offered the shortest time and a low price.	Ground problems, bad weather, statutory undertaker, landscaping.	Contractor overcame the ground problem but some delays occurred on the final stages.

17 Informal case histories

P4: Purpose	£106	500 m^2	Own management	First time

Time	Months	% difference from average
Construction	5	−6
Total	9½	−41

Site

A derelict garage and bungalow in a row of houses on a main road. The site required extensive levelling.

Description

The basic factory is 28·5×15 metres with brick/block walls to a height of 3 metres with a steeply pitched roof with concrete tiling. The office unit, 6×14 metres, is attached to one gable end and has a monopitch roof. The upper wall of the office and the gable ends above 3 metres are timber clad. The windows are 'residential' in appearance. Inside, both the office and factory are finished to a high but not luxurious standard. The factory area is partitioned into a number of laboratories and other specialist areas.

Cost analysis

The final cost was £211 per m^2, included in this is partitioning at £15 per m^2 and services at £15 per m^2.

The pre/contract period

The clients, an established high technology firm, had been searching for a site for a factory of their own for about 3 years. They found that estate agents could not help and that all suitable land was owned by developers. Finally they heard of a garage that had been bought by a competitor to close down. They offered the proprietor a 25 per cent profit which he accepted. The planning authorities recommended that, in view of the residential location, the walls should be brick, the roof tiled and the windows small. They also recommended 3 architects, one of whom was chosen. The client was already considering selfbuild and the architect designed so that the work should be suitable for dividing into small packages. The client had only 2 requests: that there be an uncluttered span of 50′ to allow for flexibility and that possession should be obtained in 9 months. Otherwise the client had no preconceived ideas about the design, he 'left it to the expert'. His only alteration was to transpose a lavatory and corridor. The design was complete 2 weeks after briefing. At that stage a number of local contractors were approached for estimates, the lowest of which was £135 000 for the basic building only, which would have resulted in a final price of £175 000.

It was then decided to divide the construction into 11 packages and to go out separately on each, using the 'yellow pages', personal contacts and recommendation. Prices quoted varied by as much as 100 per cent. At the same time the client applied for planning and building regulations approvals. All this took 3½ months.

Management

The responsibility for managing the project was taken by one of the two partners assisted by a part-time member of staff who acted as site clerk chasing up quotations and, later on, the workmen themselves. The letters of confirmation sent to successful tenderers specified not only the work to be done but also that the site must be left in a suitable condition for the following trades. The architect was not paid to supervise but visited regularly and gave help with setting out and technical problems.

Contract period

Most of the sub-contractors performed well. The ground work, which involved the removal of a lot of soil and drainage, was completed by 3 men in 3½ weeks. The bricklayer, who was paid a bonus for completing on time, took 4 weeks. During the next week a carpenter jointly with the client put up the cladding. Then a 3 week delay occurred before the delivery of roof trusses which were also wrongly finished. The tiles were also a week late but the tilers worked well. The finishing trades worked well, almost simultaneously over the next month, at one time 13 men were on site. The whole contract period was 5 months to completion. The only complaint – the windows don't close properly.

Assessment

Despite having little construction ability the client was successful in transmitting his enthusiasm for his self-management project to others. His business is in the high technology field where good organisation is important and he applied the same discipline to the project. He set up a good relationship with all concerned except the scaffolders, who at one stage threatened to beat him up. He made a point of paying all trades as they left the site. Nine months later the same group produced a 185 m^2 extension in two months.

P11: Purpose £412 1815 m^2 Management contracting Experienced

Time	Months	% difference from average
Construction	5½	−33
Total	10	−43

Site

Recycled land, part of which became waterlogged, on an existing industrial estate.

Description

A steel framed building 55×33 metres with a height to eaves of 4 metres and an adjacent boiler house 7×15 metres.

The unit is divisible into three, each section has an internal block-built loading bay. The walls are externally clad with plastic covered steel in a two tone pattern of brown and mushroom. There are a series of vertical translucent plastic panels. The roof is asbestos cement, also with transluscent panels.

The unit is heated by blown hot air units from the oil-fired boiler, which was also designed to service 7 extra units planned for the site. Lighting was provided, but the tenant erected his own office partitions at an extra cost of £3500.

Cost analysis

The final cost is expected to be £227 per m^2 of which steel frame and cladding is £48·5 per m^2, heating and plumbing £29 per m^2 and electrical £12.4 per m^2.

The pre-contract period

The tenant was already occupying another of the local council's units when he approached them explaining that he anticipated rapid expansion of his high technology enterprise. The council reacted quickly, designing a suitable unit but cautiously allowing for subsequent sub-division should the tenant not succeed.

To save time the council appointed a contractor on a management fee based on 6 per cent of the original estimate. The contractors had worked with the authority before and were chosen for their expertise and the fact that they in turn would employ smaller local contractors.

The contract was then broken down into 5 elements, civil engineering, general building works, heating and plumbing, steel frame and cladding and electrical which were let competitively. Some companies approached declined to tender as they considered the programme too tight. The steel and cladding and electrical sub-contractors were offered a fee to design before contracts were placed.

The contractor–manager

A large national contractor who had locally 60 staff and 250 operatives. On this project only 2 staff were employed on the site, but supplementary labour would have been supplied if necessary.

The contractor is increasingly interested in management fee contracts.

The contract period

The initial problems were involved with the site becoming waterlogged; it had to be pumped out and filled with hardcore, this cost £7500 but was completed in a week as quick decisions were made by the professionals involved. After this things went well until, near the completion date, the tenant decided that he required block-built loading bays which took a further 2 weeks.

Nonetheless the tenant took over one of the areas 2 days ahead of programme and the balance 6 weeks ahead of the planned 7 months.

Assessment

The professionals and contractor, who had all worked together before, were united in a common intent to produce the unit for the very voluble tenant on time. Decisions were made immediately and variations kept to a minimum.

The tenant had a few minor complaints, his major problem, however, was the expense of heating the considerable volume, especially as gas was not available.

P14: Purpose £530 4158 m^2 Project management Experienced

Time	Months	% difference from average
Construction	11½	28
Total	32½	44

Site

An ex-colliery site belonging to the local authority and adjacent to a motorway. The site required vibro flotation and strip foundations.

Description

The unit was built to the specific requirements of the client, a country-wide wholesale distributor of building materials. As the site was on a conspicuous corner, the local authority insisted upon a dramatic elevation. As it was intended to sell-on the project to a pension fund the resulting extra £40 000 was well spent. The single-storey warehouse is 3723 m^2, constructed with a steel portal frame with 7 m to eaves built to 'institutional specifications', ie with brick and plastic covered steel cladding and asbestos cement roof. The small office block, 435 m^2, is of load bearing brickwork with precast concrete floor. Both buildings feature narrow full-height windows.

Cost analysis

Anticipated final account figure £127 per m^2. The vibro flotation cost £3 per m^2, the steel frame and cladding £37 per m^2 and services £10 per m^2.

The pre-contract period

The project manager works regularly for the client producing warehouse units for their own use as they expand country-wide. The proximity to the motorway made this site particularly attractive to them but the local council was unwilling to sell. Negotiations took place from February 1978 until September 1979 when the land was purchased on a 125-year lease. The project manager had retained a multi-discipline consultancy firm with whom he had worked before.

The design was based not only upon the client's requirements but also had to be acceptable to a pension fund, for example the warehouse area is divisible and there is a high standard of finish. Planning permission was sought while negotiations continued, the documentation was completed in June 1979. They went out to tender to 7 contractors, 5 regional and 2 national, asking them to suggest a contract period. The successful contractor was already working for the client elsewhere and was chosen not on price but on the preferred contract time of 40 weeks. The lowest bid was for 52 weeks and cost £6 thousand less.

Contract

Standard form of Building Contract Private Edition with Quantities 63 Edition (July 77 Revision).

Contractor

A medium-sized company who were anxious to open an office in the area – this being their first project. The site agent was young and inexperienced and did not appear to get the backing he required. Most of the work was sub-contracted.

Contract period

The first delay was due to a sewer not being where the local Authority had indicated, this necessitated re-routing which had to await vibro compacting.

Industrial action delayed reinforcing steel and vertical cladding. The contractor complained of late nominations in particular for windows, but this appeared to result from the manufacturers' tardy response to requests for quotations.

There were a number of client's amendments during the first 2 months of the contract. There were in all some 30 AIs, the last 5 in the last 2 months. The initial alterations involved the removal of partitions, following fire officer intervention, and increased insulation.

The block supplier was replaced as the original one could not deliver in time. The contractor later claimed the replacements were heavier and more difficult to cut. The major problem appears to have been the full-height windows which required accurate brick manufacture and accurate laying. Faults in both resulted in work and materials being condemned. A further delay in that area resulted from wrong specification of lintels which delayed the bricklayers.

The statutory undertakers were slow in providing quotes and information, which in turn resulted in amendments and delayed completion of external works. Other materials' suppliers causing problems were precast concrete 5 weeks overdue following labour problems and steel doors that do not close because they have been painted.

Assessment

The contractor was new to the area and thus could not obtain good domestic sub-contractors. The nominated sub-contractors, especially the cladder, who was a sub-contractor to the steel contractor, were unable to increase their site effort to expedite progress and catch up on delays. The architectural technician was overloaded and so was late providing information, some of which may not have been required by a more experienced site agent. The bricks were unsuitable for this application.

P15: Purpose £563 $2785m^2$ Design and build Continuous

Time	Months	% difference from average
Construction	6½	−29
Total	15½	−31

Site

A sloping site subject to mine-working subsidence which required special bagged sand beneath the reinforced concrete foundations.

Description

A rectangular building 66 × 42 metres, steel framed to an eaves height of 5 metres with two canopies 4.5 metres high.

The roof is clad in plastic covered steel and lined with glass wool and plasterboard. The walls are similarly finished down to a height of 2 metres, with brick and block below.

The office within the envelope is finished to commercial standards, ie with suspended ceilings, diffused lighting and heating.

The factory finish is high quality blockwork, painted, and includes lighting and heating and electrical power.

Cost analysis

The cost is £202 per m^2 of which the steel frame and cladding is £35 per m^2, heating £12.2 per m^2 and electrical £10.7 per m^2.

Pre-contract period

The client, a diverse industrial group, own or lease about 90 factories and spend about £4 million on building and refurbishing each year. They have, as a rule, built by traditional methods, ie by commissioning an architect who fully designed and detailed the buildings. On this occasion they set out as usual to do so, giving the architect a detailed 22-page specification of which over half was concerned with services, including fire alarm and sprinkler systems.

When the architect had completed preliminary drawings, the quantity surveyor estimated a cost of around £800 000. At this point the client's surveyor decided to investigate design and build and went to 3 contractors asking for their design and specification based upon the architect's original design. The prices quoted varied between £580 000 and £680 000 with construction periods between 7 and 9 months and were received in 7 days.

The successful contractor was chosen not on price but on contract period and the fact that they had their own in-house design skills. They had, in fact, varied the design not only to make it easier to build but also to avoid lorries having to pass in front of the office block and to allow for a future extension. The contractor's own engineer designed the special foundations and negotiated their acceptance by the NCB.

Start on site was 3 weeks after the proposals were presented, two days after planning permission was received.

Management

The client employs a team of 5 surveyors who visit sites regularly, the property manager visited at 3 or 4 weekly periods, the local manager 'popped in' but could not give orders. There were no site meetings.

The contractor

There are two directors of the company, the professional engineer and an ex-contracts manager who for many years worked as a plant engineer and thus has a wide experience of being on the other side of the fence. He appreciates that the average industrial client does not want to be bothered with details of construction.

They have 50 employees, mainly bricklayers, joiners and labourers, and work in the housing and industrial fields. Design and build now represents 60 per cent of their industrial work. Most of the sub-contractors on the project were chosen on previous experience.

The construction period

As well as the expected problem with the site due to the probable subsidence, it was found that the site was 5 metres shorter than anticipated. This meant the building had to be moved, and a retaining wall added. The work, however, continued without a break, the contractor not waiting for assurances that he would be paid for the additional costs. Despite the winter start the men worked with enthusiasm, on one occasion pouring concrete illuminated by car headlights.

The problems were minor, two loads of concrete blocks had to be returned as their finish was not acceptable for their exposed location, and a special sectionalised wooden window proved to be unstable. The contractor prevented anticipated problems with the services, which had been so rapidly specified by the client, by producing a master drawing showing the way the work of various contractors inter-related at roof level. To produce this drawing cost £600 and proved to be a wise investment.

There were a few client's variations, mostly involving extra electrical and public address system work, office arrangements and finishes. In the event, due to the extra work, the project finished in 28 weeks, 2 weeks later than planned.

Assessment

This project was one of a group of three where the client has recently used the design-and-build method, all of which have proved successful. He admits that they have involved his staff in more work, in particular at the briefing and selection of design stage. He stresses that the client must be capable of discussing problems with the contractor should that prove necessary. He is puzzled to know why building with this method has proved to be so much cheaper, particularly as it appears that the buildings are identical to those that have been built previously by traditional methods. The secret could be the rigidity of his specification.

P19: Purpose £704 $3348m^2$ Design and build First time

Time	Months	% difference from average
Construction	10	3
Total	23	2

Site

An undulating area on an existing industrial estate upon which the contractor had already built. Part of the area was built-up land formed when spoil from an adjacent railway line had been used to fill in ponds. This resulted in the foundations of one corner being deeper than envisaged. An 11kv power line supported by a pylon passes over the site.

Description

The factory/warehouse area is 36 × 54 metres plus 24 × 18 metres, steel framed to an eaves height of 6 metres. The roof and cladding is pvc clad steel to a height of 8 metres including a parapet. Both roof and walls in the larger area are insulated with 80 mm of fibreglass lined with plastic faced plasterboard. Both the buildings have a block dado wall. The floor load is 20 kg/m^2 with areas reinforced to support specific machines. There are a number of offices within the factory area. The main offices are housed within an attached brick faced 2-storey office block 36 × 12 metres which has a flat roof of 3 layers of felt supported on timber joints.

Cost analysis

The final cost was £210 per m^2 of which the steel frame and doors were £16 per m^2, cladding £18 per m^2, mechanical services £16 per m^2 and electrical £9 per m^2.

The pre-contract period

The client, a foreign company already a tenant in a nearby factory, was building for the first time in the UK and spent about a year investigating the various possibilities. These included discussions with an architect, whose estimate of cost was deemed too high, and a number of design and build contractors. The contractor, who retained an outside architect to produce the design, was chosen on a budget price bid of £600 000 which was later increased as the client's and planner's detailed requirements became known. Planning permission was obtained promptly but resulted in parapets being required on both buildings and extensive landscaping at a cost of £7000.

The contractor

An international company who had built a number of similar units in the area. The site agent was a civil engineer used to handling large projects, the site engineer was inexperienced.

All the work was sub-contracted: the building work to one local contractor, who employed his own bricklayers and joiners and sub-contracted the groundwork, concreting and general labouring to gangs he works with regularly, the other sections were let as separate contracts.

The contract period

The start on site was in August and the work continued satisfactorily until October when the weather deteriorated, holding up cladding and bricklaying. Overtime work by both the cladder and the general building contractor helped to overcome this. At this stage the client requested a number of variations mostly intended to improve the appearance of the building, allow for equipment, and provide better facilities, for example a kitchen in the canteen for the work forces. This variation affected in particular the services' contractors; the electrical contractor worked well but the heating and ventilating contractor, who was already behind programme, became even more so. In all there were some 60 variations, in part due to lack of detailing by the architect, and the re-location of a gas meter house to satisfy the statutory undertakers.

Assessment

The advantages in the design-and-build method of having all the responsibility with one organisation can be reduced when the design and detailing are undertaken by outside architects. In addition a 100 per cent sub-let contract requires an active and conscientious site management exerting rigid control. To an extent the shortcomings of the management on this site were compensated for by the 'old fashioned' local contractor who was not, however, responsible for the other sub-contractors who appear, together with the client, to be the main causes of the month's delay.

P23: Purpose £1227 7180m² Traditional Experienced

Time	Months	% difference from average
Construction	6	−48
Total	9½	−58

Site

A former housing site offered by the local authority. It required piling and had a number of unmapped sewers.

Description

A steel frame extension to match the existing building – 140×56 metres with an eaves height of 9 metres. Two cranes requiring steel work and floor rails and dock levellers were installed. The unit was fully serviced.

Cost analysis

£171 per m^2 of which the steel frame was £24 per m^2, cladding and roof £23 per m^2, services £12 per m^2 and piling £7 per m^2.

Pre-contract period
The client had been offered the land some 2 years previously and had held some discussions with the architect with whom he had worked for the last 10 years. The plans were at that time shelved and were not discussed again until the appointment of a new managing director when the government's intention to withdraw grants resulted in a decision to go ahead with a less ambitious extension. To qualify for a grant this would have to be completed in 9 months with construction taking less than 6 months. The planners, influenced by councillors anxious to create more jobs, were co-operative but nonetheless demanded a brick dado wall and specified the colour of steel cladding. The building regulations officers and statutory undertakers were not so conscious of the need for speed, taking 4 weeks to answer letters.

To further shorten the pre-contract period, the architect decided to go out to tender on a bill of approximate quantities to 7 contractors. The lowest tenderer had overlooked the very important fact that access to the existing factory had to be retained. The staff of the successful second lowest tenderer also appeared to be keener and regarded the potential timetable as a challenge not an obstacle. The steel work contractor was chosen on price and recommended the cladder.

Contract
JCT 'old version' – fixed price.

Contractor
An old established local contractor with 598 employees (58 apprentices). On this particular project the only tradesmen not directly employed were joiners. The level of supervision was high: project manager, site engineer, general foreman and trades foreman.

Contract period
Many of the problems were involved with the site works – obstructions had to be removed and the location of a culvert eluded them for 2½ months even after searching to a depth of 8.5 metres and employing a water diviner. The work resulted in flooding of the existing building's basement, requiring a new drainage division. Electricity cables also had to be diverted after prolonged negotiations. The steel strike delayed the delivery of purlins and an alternative section was substituted. Finally the sheeting was delayed by high winds requiring an extra gang to catch up, and the fencing contractor had to be replaced after material supply problems.

Assessment
The multi-discipline design practice could act quickly to assess the client's requirements and supply promptly the information the contractor required.

The architect of the 'old-fashioned school' visited the site twice a week and struck up a good relationship with the site staff. The project was not only quick but efficient. The labour content was low in relation to others in the sample. The main contractor likes a short time-span for a project of this kind as it does not allow a client to change his mind. The client for his part placed on record his satisfaction with the manner and approach with which the consultants and construction team had co-operated to maintain progress and complete the works within the contract period.

P27: Purpose £1507 5400 m^2 Project Management First time

Time	Months	% difference from average
Construction	9	−27
Total	13	−42

Site

Made-up land which required piling.

Description

A steel frame unit 132 × 37 metres; 6.6 metres to the underside of the portal rafters. The vertical cladding is pvc coated steel, the roof asbestos cement. The office block is fronted with brick, internally the walls are plastered and there is a suspended ceiling. The unit is fully serviced.

Cost analysis

The final cost is £279 per m^2 of which £41.5 per m^2 is the steel frame and cladding, £104 per m^2 services and £4.5 per m^2 piling.

The pre-contract period

The client had had a preliminary design produced that proved to be too expensive when he approached the project manager explaining that he would like to be in possession of his factory within 12 months. The project manager contacted the consultants with whom he had worked regularly and explained to them the conditions which they accepted. This, assuming a construction period of 39 weeks, allowed them only 3 months preparation time. In this period a full bill of quantities was produced despite the client's frequent changes of mind. During this period discussions were held with a number of contractors to ascertain their most economic as against fastest time. The economic times varied between 42 and 52 weeks and the quickest 35 to 42 weeks. In the end the contractor was chosen not on price but on the basis of making a good presentation. The professionals feel that where a high proportion if not all the work is to be sub-contracted, then there must be a high calibre of staff.

The contractor

A large multinational contractor who has a considerable local presence – both professional and tradesmen. However on this occasion, because of the short mobilisation and contract period, he decided to sub-contract all the work to local builders and specialists. This required a high level of supervision not only on the site, agent, foreman and engineer, but also at regional level.

The contract period

The work which started in July went smoothly for the first few months with the piling, groundwork and steel erection on programme. The steel contractor had, however, sub-contracted the cladding to men who had not been told the standard of workmanship required. Similarly the services contract which had been let as a package to avoid possible conflict was not co-ordinated and the electrical work sub-sub-contracted.

In addition during this period there were a number of changes due to clients or statutory requirements which resulted in some 88 AIs at a cost of about £150 000, mostly for services. Nonetheless the contract finished on time and the client obtained limited access ahead of completion which resulted in his being in production one week after completion of the contract.

Assessment

Throughout the period there was close co-operation between the project manager, consultants and contractors. The degree of sub-contracting, over half nominated, combined with a tight programme meant they would have been unlikely to succeed without the high calibre of site supervision.

P30: Purpose £2180 $9081\ m^2$ Traditional First time

Time	Months	% difference from average
Construction	28	100
Total	37½	66

Site

A sloping site, adjacent to an industrial estate.

Description

Basically two buildings connected by a covered walk-way 15 metres long. As the site is sloping both buildings have lower floors used as service areas which allow the main part of the offices and factory to be at the same level. The production unit is steel frame, 87 × 84 metres; height to eaves 6 metres. The lower walls are brick and block and the upper insulated plastic covered steel. The triple span roof has asbestos cement covering. The 2-storey office is of brick construction with a flat roof. The finish of the office unit is that usually found in a commercial building.

Cost analysis

The final cost, which is still disputed, is expected to be about £240 per m^2 of which the steel frame is about £18 per m^2, cladding £16 per m^2 and services £30.5 per m^2.

The pre-contract period

The client had been hoping to expand for about 2 years and had enquired about a site when suddenly he was offered the land, without planning permission, by an owner anxious to sell. The local managing director had to refer to his head office who asked a national estate agent to value. A month later the land was purchased. The estate agent then recommended an architect and an application for planning permission was made 4 months later. During the next few months, while negotiations were taking place with the planners, discussions were held with the 15 nominated sub-contractors. The project then went to tender to 8 local and national contractors, 7 months after the land was purchased. The contract period specified by the client was 10 months for the factory and 12 months for the office block. The contract was won by a large regional contractor anxious for work.

The contractor

An old-established firm, part of a construction-based group with a turnover of £29 million. There are 150 construction employees, 100 on site. It concentrates on public and commercial work with only about 10 per cent being industrial.

In addition to the 15 nominated sub-contractors on the site there were 17 domestic sub-contractors as well as unrecorded 'labour only'. The site agent, who was ultimately replaced, was managing his last contract before retirement.

The contract period

From the first the project progressed slowly, mainly because there was a shortage of shuttering carpenters owing to local motorway contracts. The architect was described as vague and slow in producing information. In all, some 109 drawings were produced with amendments running up to suffix 'p'. There were, in addition, 73 sketches.

Many of the sub-contractors performed badly, many in turn blaming the architect for not producing information. When, after 5 months, the client realised that work on the office block had not even started, he contacted a director of the contracting company and asked him to intervene. Only then was a programme of work produced. Even that shows that the steel frame was not yet completed (the sub-contractor went out of business) and the vertical cladding had not begun. By the end of the year the contractor was claiming for 28 weeks' delay, 27 for late information and 1 for the weather.

The client at last got possession of the factory unit 9 months late. The architect then granted the contractor 14 weeks delay on the factory – 8 for weather and 6 for variations, and 26 weeks for the office – 15 for variations and 11 for weather. In all, 64 architect's instructions for variations were issued, resulting, in fact, in little extra work in value terms.

The office was finally completed 14 months late. Even then there were problems: windows fitted badly, drains were unconnected and ceilings and floors damaged.

The factory loading bays allowed cold air to enter and the client had to bring in a smaller contractor to build screens.

In all the delay of 14 months could probably be fairly attributed to: 33 per cent variations, 20 per cent weather, 25 per cent lack of labour and 22 per cent poor management.

Assessment

This is a classic example of 'how not to'.

The client had no experience of construction and was in a hurry – with expensive equipment on order to satisfy his market. As one machine alone cost about half as much as the buildings, it seemed a waste of time going out to competitive tender. It might have been better to negotiate a price, perhaps design and build with an experienced contractor.

The architect was inexperienced and located too far away to supervise the project properly. At the very least a clerk of works should have been employed.

The contractor – the number of sub-contractors on the site required a higher level of supervision, not a contracts manager who was simultaneously managing 7 or 8 other projects. The lower price they had put in to get the job resulted in the low priority given to it. In the circumstances the client would probably have received better service from a smaller company.

P33: Purpose £3400 13 460 m^2 Traditional First time

Time	Months	% difference from average
Construction	18½	19
Total	26½	0

Site

An existing estate on which the manufacturer was already a tenant of a development authority. The site, adjacent to the tenant's unit, had housed an ordnance factory, and contained old concrete, manholes, etc.

Description

The production unit, area 9860 m^2, has a steel lattice frame. About half is built to an eaves height of 14 metres and the balance to 7 metres. The facilities block, area 3600 m^2, is predominantly two storey. It contains not only offices but also recreational and welfare facilities. Both buildings are finished to a higher standard than is usual for industrial units.

Cost analysis

Total cost £252 per m^2, steel frame £43 per m^2.

The pre-contract period

The manufacturer, a foreign company with no building experience in Britain, approached the authority in December 1978 stating the area and height requirements in general terms with an outline drawing together with their anticipated timetable, ie building to begin May 1979, limited access for the installation of equipment February 1980 and total completion May 1980. The authority were dubious but agreed, after consultation, to accept 'an exceptional challenge'.

The architect produced two outline drawings in the first week in January 1979 and his firm design proposals a month later. He proposed a site start in mid-July with 'use and occupation' by March 1980.

During the next 5 months 23 meetings were held to discuss the design with the tenant and try to speed up the flow of information. That required for the production area was straightforward, hinging on the requirements of the plant to be used, loadings, etc. Details for the facilities block were more complex as the tenant was vague, they did not want an 'office block atmosphere' it was to be 'flexible, inviting and readily accessible'.

To save time while the information was being collated and approved by the authority, a site preparation contract was let to begin May 1979, and in the event this was extended to include bases for the production area. The main contract was let to a different contractor in July 1979, to start 6 August 1979.

Contract

Both contracts were let by competitive tendering, and the JCT 63 form of contract was used.

Contractor

An international civil engineering contractor with little experience of this kind of work. Most of the work was sub-contracted, the main contractor's men being used only for groundwork and concreting.

Management

The position was complicated by the fact that the authority was the client and yet the requirements were for the most part those of the tenant. Large numbers of individuals were involved, for example there were up to 19 present at pre-contract meetings.

The authority had to sanction all work, even that included as 'tenants' extras'. In addition the tenant was having work of his own undertaken mainly in the services field which involved, in many cases, the same nominated sub-contractors. The tenant was not represented at site meetings and appeared to meet the contractor rarely at a management level.

The contract period
This started very slowly after the footings had been installed for the steel as the steel contractor was affected by a suppliers strike, despite the fact that in August he had declared that the steel for the production area was 'in his yard'. The effect of this was increased as the network of sub-contractors and suppliers were all suffering in various and unpredictable degrees. The result was that the steel contractor started on site with 4 fabricators in October, 6 weeks late, and made very slow progress, in part due to distorted trusses from sub-contractors. Some attempt was made to improve the situation by site welding and working through the Christmas holiday. This delay affected the following trades who, in some cases, took the opportunity to leave the site altogether.

By March 1980, the tenant was getting desperate, and accepted the contractor's offer to accelerate the work to give phased 'use and occupation' from May to July for a sum of £152 000, to enable plant to be installed by 1 August. Despite this, delays still occurred due mainly to specialist sub-contractors not complying with the contractor's latest programme (there were 4 programmes in all), so holding up following trades. The standard of work was such that sections were condemned, and the resulting remedial work in turn led to delays. Materials, or rather lack of them, also caused delays, the bricks were late in arriving and mis-shapen. In addition the weather continued to cause delays, the roofer and cladder recording 21 per cent of man-days lost for this reason.

After the handover of the production block in July 1980, work was concentrated on the facilities block. Again specialist nominated sub-contractors, who could not be replaced, continued to cause delays, and the many following trades tended to get in one anothers way. In the end the architects, despairing of the contractor's ability to handle things, installed their contracts supervisor to co-ordinate and avoid damage to work already done. The tenant was now having work done in the production area and was accused by the contractor of diverting the services sub-contractors' labour.

Assessment
Overall the contract over-ran by 28 weeks. The contractor was 'allowed' 25 of these, 7 weeks for the effects of the steel strike and 18 weeks for variations. This latter allowance seems excessive: although there were 235 AIs resulting from changes in the tenant's requirements, most of these were minor, and their additional cost was only £124 000.

A major factor was the apparent inability of the main contractor to exercise effective control. Delays at the start led to programme changes, and sub-contractors were not able to meet revised schedules.

P34: Purpose £2900 6430m^2 Design and build Experienced

Time	Months	% difference from average
Construction	12	−20
Total	21	−19

Site

Recycled land containing submerged obstructions immediately adjacent to the client's existing factory.

Description

There are two buildings. The first, the production area, 105×43×8 metres high, mainly single storey, but with a partial mezzanine, and adjacent a 46×8 metre 2-storey office block. The frame is steel, the roof of glassfibre and bitumen felt on insulation board. The full length vertical cladding for the factory is white plastic covered steel with insulated sandwich and galvanised steel lining. The curtain walling for the office area is tinted glass in aluminium framing.

The smaller building, the energy centre, is 36×9 metres, clad similarly to the main factory. All buildings are fully serviced and finished.

Cost analysis

The final price is £449 per m^2, of which the external works are £54 per m^2, buildings £194 per m^2 and services, including some process plant, £201 per m^2. (The remainder of the process plant was installed under a separate contract.)

The pre-contract period

The client, a foreign company, was in the process of having a unit built on the adjacent site when the requirement for this building arose. It was decided that rather than overload existing staff, a new team should be set up to oversee its production, and eventually participate in running the factory.

With the help of the parent company a detailed specification was prepared and a series of meetings held both in the UK and abroad where a similar plant was already running.

They had previously experienced difficulty with a similar high technology plant in co-ordinating the activities of the contractor and the plant installation sub-contractors and so favoured a contractor who would provide a complete package. The contractor approached makes a speciality of providing such a service.

Discussions and preliminary design and planning permission took 4 months during which time the contractor's staff visited the client's parent company.

Contractor

A national company specialising in engineering-based design and build. To avoid a conflict of interests the contracting and design sections of the company have their activities on each project co-ordinated by a project manager who has direct responsibility and is the main contact for the client. On site there is a staff of 6: site manager, general foreman, site enginer, site architect and separate mechanical and electrical supervisors.

They sub-contracted all the work except steel erection to sub-contractors who work for them regularly, producing separate programmes for each sub-contractor based upon their estimated labour requirement. Performance is closely monitored so that possible over-runs can be anticipated and the labour input adjusted accordingly. They also provide the customers with design and procurement programmes clearly indicating decision deadlines to avoid information-based hold-ups.

Contact period

The initial stages progressed well, although more rock than anticipated was discovered. The main problems occurred with the services contractors, in particular with congestion in the energy centre.

Despite the contractor's rigid attitude to variations, none is put in hand until written approval of the cost is obtained from the client and his quantity surveyor, there were 98 in all. Most were involved with the process. Those involved with the structure were an acrylic finish to the inner lining, extra kitchen equipment, treatment to the floor slab, partitions and doorways, fire escape, lift, lighting, roadways and fencing.

In addition, the client requested that part of the production area be completed in 9 months, instead of 12, to allow plant installation. The major part of the contract was completed ahead of the estimated completion date in spite of variations.

Assessment

Both the teams, that of the client and contractor, were highly skilled, motivated and compatible, giving times significantly faster than the average for both construction and pre-construction work.

A7: Advance   £427   3160 m²   Traditional   Continuous

Time	Months	% difference from average
Construction	9	2
Total	17	−3

Site

A local estate agent told the developers in August 1978 that the council was selling an industrial site on tender with a design brief. They briefed an architect, tendered and were accepted in January 1980. The purchase was completed in June 1980 after planning permission had been obtained. The site was supposed to be serviced but actually was not. No major ground problems – green-field site of clay and rock.

Description

12 units of various sizes from 115 to 505 m^2 in 1 block with 9 per cent office area. Steel frame with fire protection cladding, brick to 2·5 metres, plastic coated metal above. Asbestos cement roof with 10 per cent of area transluscent. Eaves height 4·3 to 5·5 metres. Floor loading 500 lb per sq ft. Roller shutter doors. Mains services. No heating.

Cost analysis

Total £135 per m^2, of which steel was £13 per m^2.

Pre-contract period

Out to tender in May 1980 to a selected list of 6 contractors, the lowest bid was chosen. The only nominated sub-contractor was for steel, again a competitive quote. The developers prefer to avoid nominated sub-contractors as far as possible to avoid possible come-back from the main contractor should they not perform, but to speed construction it is necessary to order steel early.

Type of contract

JCT 63 without quantities. The developer will not use JCT 80 which is understood to put too much onus on the architect – not professionally trained to handle it. They like an architect who will take responsibility for the design and not expect the client to take decisions.

Choice of professionals

The architects are a large firm with offices in 5 cities. The choice was based on previous experience, good at pre-contract work. They delivered 29 drawings to the contractor one month after start on site. Acted also as quantity surveyor and engineer (fee somewhat over 6 per cent). The client would use a separate engineer in future.

Design

The local authority laid down an initial planning brief. The client specified the size of units and asked for good site density (around 40 per cent). He required high fire standards (6 rather than 4 hours) to reduce insurance premiums. In retrospect the client would have different sizes of units, pay more attention to details such as guttering, steel round openings, checking of sub-contractors. The architect prefers flexibility in specifying components: 'x' or similar. His experience shows this helps speed. On the whole he keeps designs simple for ease of construction.

Contractors

The main contractor was a large national. As the job was at a distance from their base, they used local labour and tried for the cheapest. Their own operatives were only used for part of the groundwork.

Contract period

The client decided the period: 9 months. Progress at the start was very fast, it appeared that completion 3 months ahead of schedule might be possible. Then the cladders caused a hold-up, partly due to complexity of fire regulations, partly because cheap unskilled local labour was used. The main contractor maintained that this was necessary to maintain his competitive position. Completion was on time.

Supervision: the builder used a contracts manager and site agent. The architect visited weekly and the client's representative (building surveyor) about once a month. The client complained of neglect of standards by the site agent, he had to get on to the contractor several times. The foreman was not considered effective or co-operative.

Statutory undertakers

Although the site was supposed to be serviced, the client had to pay: dispute with gas board (20m rule), £6000; electricity including estate sub-station, £14 000; water £5000, total about 5 per cent of total value.

Assessment

Site time was about average. Cost cutting appeared to reduce speed – to achieve the low tender figure the main contractor used cheap local labour which resulted in some performance problems. Supervision by the main contractor could have been better, caused the client some extra work in pressing for better standards. If these problems had been solved, completion could have been earlier.

Pre-site times were short for a traditional competitive contract. Drawings and tendering were in hand before planning approval was obtained. The architect was efficient at the pre-contract stage (large, experienced firm), but less efficient at supervising site work.

A8: Advance £507 2500 m^2 Traditional Continuous

Time	Months	% difference from average
Construction	6	−35
Total	25	11

Site
Re-used, a former housing site. Sloping and with a large sewer running across. Bought from the local authority, the developer already owned an adjacent plot.

Description
Two steel-framed buildings with brick end walls and colour coated profiled steel cladding to ground level elsewhere. Steel cladding to roof, flow-clad curved eaves, height 3·7 metres. Each building divided into 6 units with toilets and sectional overhead doors. Floor loading 600 lbs per sq ft. Services laid on but no heating or lighting installed. Site cover 42 per cent.

Cost analysis
Tender price £203 per m^2 included £6 per m^2 for accelerated completion: dearer foundations and the estimated extra cost of speed – labour overtime (£3750), reduced efficiency (£2700) partly offset by savings in contractor's management costs (£3000) as well as in client's interest charges (£6250).

Pre-contract period
The architect, who had advised the developers before, produced sketch plans early in 1979 for 10 units to give 'most on site'. Planning permission, applied for in June 1979, took 3 months. A bill of quantities and 37 drawings were prepared by February 1980, and tenders invited for a 10-month construction time, decided by discussion with professionals. The client thought the tenders too high and then decided, for tax purposes, to build 12 smaller units. The new planning approval was obtained in July 1980, and a new price negotiated, but the client then delayed his decision after finding prices were cheaper in the south. Finally decided, in October, to go ahead if completion could be achieved in early April 1981, ie halving the original period. The contractor undertook this for an increased price and on condition that he was given full responsibility for the project.

Contractor
A company formed by a group of previous employees of larger firms. Turnover £4 million, half in design and build, the rest contracting only or their own developments. Tend to specialise in industrial work with jobs varying from £0·5 to £1·5 million, generally within 40 miles of their base. The company employed 180 site operatives and had their own ground working plant. The workload was heavy at the time of this contract. The director was keen to meet the challenge of the short time-scale. Only 2 nominated subcontractors were used.

Management
The contractor provided a full-time site manager and engineer and a director part-time.

Contract period

The contractor made a number of design alterations to speed up the work:

- instead of cutting and carrying away, the site was levelled and compacted and the units lifted up
- by repositioning the buildings a retaining wall was avoided
- foundations were on a ring beam to speed erection of the frame and cladding and achieve a dry site for floors. Deeper and more expensive foundations were needed because of the nature of the ground.

To meet the deadline there was a high level of resourcing – 42 men on site at the peak, which produced problems with material deliveries and handling. Statutory undertakers, apart from Telecom, were very unsatisfactory, a great deal of time had to be spent contacting suppliers to get services when required.

Assessment

The keenness and co-operation of the contractor gave a site time 3 months faster than average. The cost per m^2 was high, partly due to the extra cost of speed. This had been made necessary by the client's indecisiveness in the pre-construction period – his methods of development are still being evolved.

SPECIAL STUDY: £17 000 23 400 m^2 Design and Build Experienced Purpose

Time	Months
Construction	24
Total	34

Site

26 acre green-field site in north-east England developed with full cooperation of the local authority.

Description

A purpose-built food processing plant for a large established firm needing to increase capacity in the northern part of the country. Basically a steel portal frame, steel clad with complex services, coldstores, special hygienic finishes. A separate 3-storey pre-cast RC frame block with brick finish for personnel use is adjacent.

Cost analysis

The £725 per m^2 cost included a very high proportion for complex services and for the particular hygienic standards of service and finish required.

The pre-construction period

The client, a major frozen-food manufacturer and a subsidiary of an international group, decided in October 1979 that a complex new facility was needed even though at that stage no particular site had been finalised. They had a good working knowledge of the kind of facilities required since they had built factories for their own particular use before. They needed the facility by the end of 1982 and would take that period of time themselves to produce the improved processing plant that they intended to use. The parent group also had background knowledge and expertise available from their operations in Europe and the USA.

The approximate timetable was:

a) The client produced an outline specification and asked for tenders on a design-and-build basis from 3 firms.
b) The firm ultimately chosen raised a checklist of over 2000 items the client would need to decide before proceeding.
c) The same firms resubmitted tenders on a revised specification against a fee. Further revisions were included in the contract let to a large national organisation with construction, design, services and plant facilities.
d) The client had a team of 6 serving his interests. The contractor, as well as the normal professionals and site management staff, had a co-ordinator to expedite information flow.

Contract period
The construction side of the organisation chosen were on site within days of the final contract being agreed and have expedited progress to the utmost, carrying out work to the value of at least £1 million for each of the first 15 months of the contract. Initially the client wanted the whole project completed before handover but subsequently found the need for a more staged handover; in particular, the workshop/stores facility at the extreme end of the complex had to be commissioned and operational by the time the remainder of the complex was to be handed over. The remainder of the complex, which had particularly complicated services, had to be commissioned, and the client's team thoroughly acquainted with the functioning of the building itself by the time the processing plant came to be installed.

The design-and-build contractors were directly responsible for:

a) designing
b) quantifying and costing the design
c) designing, quantifying and costing most of the services to be provided
d) planning and programming the main contract and the services included
e) overall management and integration of the project.

The client had a number of specific requirements, including the nomination of the specialist refrigeration contractors/consultants.

At the start the initial tender/design exercise was done before a specific site had been chosen. The local authority in the area selected was keen for its site to be used. This meant that subsequent planning/control problems were eased. The site in the north-east had been chosen by the time the final contract had been agreed. Ground conditions on the chosen site proved more difficult than had been anticipated, with more extensive piling than had been originally thought necessary. All the major services to the site were available and although not absolutely straightforward, provided no significant difficulties.

Assessment
The work was completed within the time laid down by the customer, finishing in August 1982, two years after the start on site.

Part IV Appendices

Appendix A

Structure and scope of the research

The scope of the work for each line of enquiry has been:

Statistical analyses

Statistical data from some 5000 projects built between 1980 and 1981 have been analysed; this compares with 8000-9000 industrial building projects costing more than £10 000 started each year. About half the sample came from the DoE data base of returns made by contractors; the other data source was a commercially published weekly list of new projects, less rigorous in concept but more detailed in respect of information about individual projects. The function of the large data base was to establish a reliable background description of the time performance of the industrial building sector to make it possible to

- generalise with confidence from the findings of the smaller scale detailed studies;
- concentrate on sub-groups of particular interest, for example purpose-built sites, without losing sight of their context.

Case studies

Case studies of 56 recent industrial building projects were studied. These include 35 projects purpose-built for specific clients and 21 contracts for speculative advance units built for letting. The case histories cover the entire timetable from inception to completion on site and are based on evidence taken from all principal parties to the project as well as from contract documentation. Less detailed data were also obtained from another 114 projects due to start in 1980/81. This has afforded more broadly-based results for some of the major aspects and relationships identified in the case studies.

Pre-construction phase

In addition, the pre-construction histories of a further 26 selected industrial building projects were studied. Emphasis was on the client – his internal structure, resources and reasons for building – the organisation of professional inputs, the timing of the project and the tasks included in pre-construction. Supporting evidence has also been obtained from a number of organisations concerned with industrial development, these included a major pension fund, the British Property Federation, the RIBA Client Advisory Service and several clients and architects.

Construction phase

Finally, for the construction phase:

- detailed enquiries were made into the construction phase of a further 22 projects: these have concentrated on the characteristics and resources of the contractors; and on site aspects and factors related to the timing, speed and control of progress of projects;
- two very large projects, where speed was aimed for and achieved, were observed and chronicled;
- a sub-sample of 10 of the case studies has been selected for critical appraisal of their designs in respect of buildability, ease of construction and the presence of factors conducive to speedy construction;

– the same sample was also used for a detailed examination of contractors' programmes; their programming methods, resourcing levels, tightness, overlap and extent of simultaneous working, methods of control and up-dating. Alternative 'crash' programmes have been developed as a desk exercise for three of these sites in order to assess the potential for and the resource cost of speedier construction;
– preliminary investigations into the methods of operation and performance of sub-contractors, including discussions with 5 major sub-contractors who had been involved in several of the projects studied.

Opinion-based enquiries
A total of 26 people were interviewed from 20 organisations. All organisations were known to have experience of fast industrial projects. The interviews were structured to cover general views, contractural and administrative aspects, views on the building team and technical considerations.

Appendix B

Project durations

B.1 Pre-construction

The average time from the decision to build to the start of work on site was 11 months. Table B.1 shows a more detailed breakdown for three stages of the pre-construction process, ie

- decision to build to planning application
- planning application to approval
- planning approval to site start

For one in ten of the case study projects work started on site within 4½ months of the decision to build and for the separate stages the fastest 10 per cent of times were less than 2 months. Pre-construction times did not show any general increase with project size. Advance projects tended to be somewhat faster than purpose-built, averages 10 and 12 months respectively. When contracts were negotiated, there was an average saving of one month over projects using competitive tendering.

B.2 Construction times

On average, construction times increased with contract value, although not in proportion. Table B.2(i) gives the average times for 8 contracts valued between £100 000 and £3 million. The fastest times achieved by case study projects in each value band are also shown. Overall, 20 per cent of projects achieved these fast times. Projects using non-traditional organisation methods tended to be faster than average. This is discussed further in Appendix C.

Figure B.2 illustrates the distribution of construction times obtained from a large national sample of statistics for industrial buildings. The duration ranges for various proportions of projects in 12 contract value bands are shown, indicating the fast times achieved in each size group and the wide range overall between the fastest and slowest times, even after excluding the extremes at each end of the range. Average times from the graph, as well as the range of fast times are tabulated in Table B.2(ii).

B.3 Total times

Average times from decision to build to completion are given for 8 contract values in Table B.3, and fast times achieved in the sample are also shown. Thus several projects with values between £100 000 and £500 000 were planned and completed in 6 or 7 months; for projects from £0·5 to £1·0 million fastest times were about 10 months, and some larger projects up to £2 million were planned and completed in 13 months.

Table B.1 Pre-construction times

Stage	Average time (months)	Times achieved by the fastest projects (months)
Decision to build to planning application	4	1
Planning application to approval	3	1½
Planning approval to site start	4	1
Total pre/construction time	11	4½

Table B.2(i) Construction times

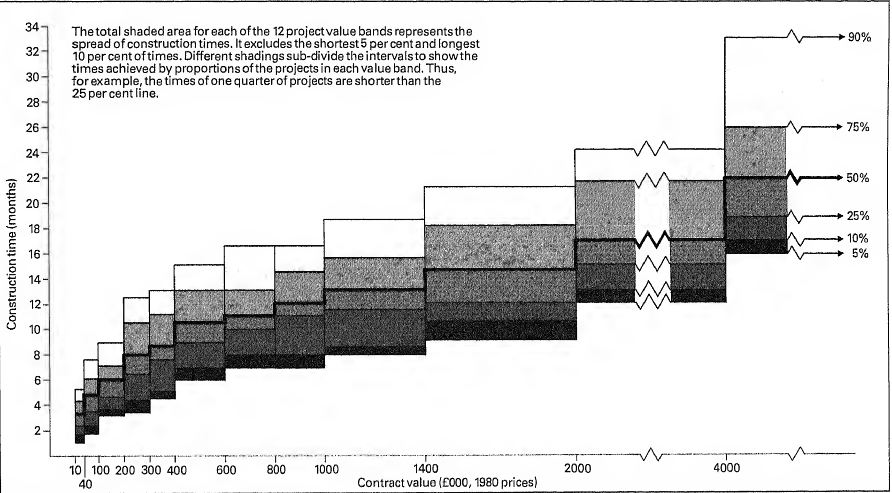
Contract value, £000, at 1980 prices	Average time (months)	Times achieved by the fastest 20% of projects (months)
100	5	4
250	7	3–4
500	9	5–6½
750	10	7
1000	11	6, 8½
1500	13	9–11
2000	14	11½, 12
3000	15	12, 13½

Table B.2(ii) Construction times statistics

Value range (1980 prices)	Average time (months)	Range of fast times (months)
£10k–£40k	3½	1–2½
£40k–£100k	5	2–3½
£100k–£200k	6	3–4½
£200k–£300k	8	3½–6½
£300k–£400k	8½	4½–7½
£400k–£600k	10½	6–9
£600k–£800k	11	7–10
£800k–£1m	12	7–11
£1m–£1·4m	13	8–11½
£1·4m–£2m	14½	9–12
£2m–£4m	17	12–15
£4m–	22	16–19

Notes:
(1) The 'average time' corresponds to the 50 per cent line in figure B.
(2) One project in five had a construction time within the range of 'fast' times.
(3) The number of projects above £2 million in price in this study is comparatively small.

Figure B The construction times of industrial building projects



The total shaded area for each of the 12 project value bands represents the spread of construction times. It excludes the shortest 5 per cent and longest 10 per cent of times. Different shadings sub-divide the intervals to show the times achieved by proportions of the projects in each value band. Thus, for example, the times of one quarter of projects are shorter than the 25 per cent line.

Table B.3 Total times, decision to build to completion

Contract value, £000, at 1980 prices	Average time (months)	Times achieved by the fastest 20% of projects (months)
100	16	6–8½
250	18	7–9
500	20	10–12½
750	21	14½, 17
1000	22	9½, 16½
1500	24	13, 17
2000	25	13–18½
3000	26	21

Appendix C

Project times with different methods of contract organisation

Details of the 56 case study projects classified by the method of contract organisation are given in the following tables. Within each category the projects are ordered by their relative speed of construction on site.

The measure of relative speed used is the percentage difference from the 'norm' – an average time obtained from the sample for projects of similar size. This percentage measure, together with the actual site time, is shown in the second column. Thus, purpose-built project P23, with a site time 48 per cent faster than the average for a project of this size, appears first in the group of traditionally organised projects and purpose-built project P30, 100 per cent slower than average, appears last.

Actual total times from inception to completion and the percentage difference of the total time from the average are also shown. For each project the difference between the two percentage deviations from the average, ie between the relative total and the relative site time, indicates the speed of pre-construction. For example, purpose-built project P23, with a total time 58 per cent faster than average, had a relatively short pre-construction time, whereas the next project, advance A8, had a long pre-construction time, giving a total time 11 per cent longer than average, although the site time was very fast.

The level of sub-contracting and the type of contracting, competitive or negotiated, are tabulated, followed by notes on important factors and circumstances which have influenced fast or slow progress on site as well as the course of pre-construction.

There was a wide range of performance within each method of contract organisation, but a higher proportion of projects where non-traditional methods were used had fast times.

Method of organisation	Percentage projects with *site time*			Percentage projects with *total time*		
	*Fast	Average	Slow	Fast	Average	Slow
Traditional	17	37	46	25	29	46
Own management	20	40	40	40	20	40
Design and build	47	11	42	47	21	32
Separate management function	50	38	12	63	12	25

* 'Fast' projects are those completed at least 10 per cent faster than the norm.
'Average', completed within 10 per cent of the norm.
'Slow', taking at least 10 per cent longer than the norm.

Figure C illustrates these findings.

Figure C The effect of method of organisation on the distribution of site times and total times in the case study sample

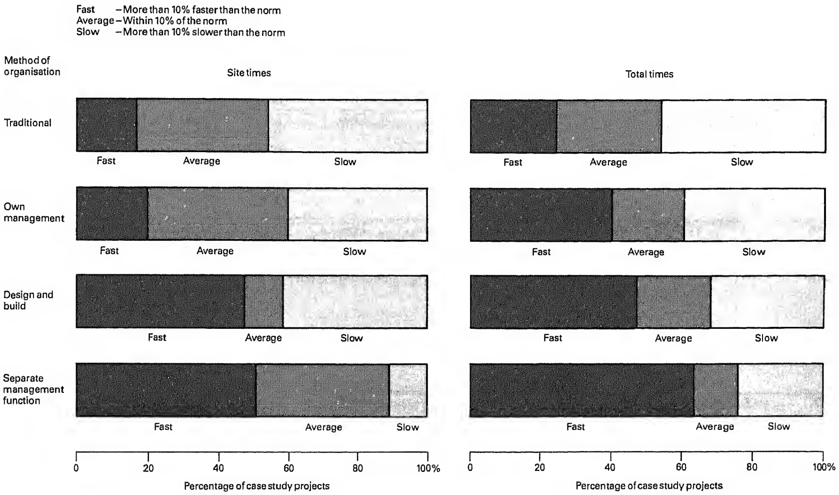


Table C1 Traditionally organised projects

	Site Time				Total time			
Project no	% differs from norm	Actual months	Contract value £000	£/m²	% differs from norm	Actual months	Amount of sub-contracting	Main influences on site times
P23	−48	6	1227	171	−58	9.5	Low	Customer deadline; previous experience with architects, large practice; keen contractor, industrial building experience. Building regulations approval after start on site.
A8	−35	6	507	203	11	25	Low	Customer deadline; keen contractor, industrial building experience, changed design for speed, high resourcing levels, good back-up.
P26	−17	10	1358	242	19	27	Low	Large client, experienced with continuous building programme; supervised, minimised changes in requirements; local contractor; sub-contractor delays; problems with site management. Site manager replaced.
P16	−13	8	583	139	−25	17	Low	Large client, minimised changed in requirements; site management and sub-contractor problems; difficult ground conditions, extra resources to make up for delays.
P6	−9	5	118	332	75	28	Low	Large client, experienced with own building department, froze design; supervised; local contractor. Sub-contractor problems.
A3	−4	7	229	143	19	19	Very low	Low-lying re-used site; material deliveries, weather, tenant negotiations all caused delays but skilled contractor and good co-operation gave a fairly fast time.
A16	−4	11	1060	160	6	24	Low	Four months needed to deal with soft spots in re-used ground, but a good team and efficient site agent minimised delays.
A10	−3	9	526	153	−25	17	Major trades	Contractor thought time, specified by client, could have been shorter and finished ahead of schedule despite ground problems and material delivery delays. No variations.
A14	1	11	893	298	6	24	Low	Most of the 2-month over-run caused by changes required by district surveyor. In spite of this, and the complexity of the conversion, an average time achieved by on-site decision-making.
A7	2	9	427	135	−3	17	High	Difficulties caused by contractor, outside his usual area, using cheapest local labour and not providing adequate supervision.
A18	2	13	1425	225	33	18	Major trades	A waterlogged site and obstructions delayed foundation work. The developer's policy of working with a regular team helped solution of problems. Particularly close involvement and supervision by project architect.
P24	3	12	1227	266	−16	19	High	Average time but longer than planned due to ground obstructions, late design information, and labour problems of contractor working outside his usual area.
P21	6	11	866	250	42	32	Very low	Contractor lived up to his reputation by completing early despite alterations in the design and delays by steel contractor holding up subsequent work.
P33	19	18.5	3400	252	0	26.5	High	First British project of overseas' tenant with complex needs; passed through a development agency, gave poor communication and information flow. The contractor, inexperienced in this work, sub-contracted heavily and did not provide effective supervision.
A17	19	14	1159	209	−5	21.5	High	Poor supervision, site agent replaced; ground problems; design complexity.
A12	20	12	654	212	−12	20	High	Ground problems; tenant amendments.
P20	25	12.5	793	176	48	33.5	High	By public body for tenant; tenant indecision and changes in requirements; large contractor, not industrial specialist, gave low priority, poor supervision.
A5	29	11	389	143	59	27	High	Poor supervision, site agent replaced; ground problems.
P17	30	12.5	700	163	8	24.5	Major trades	By local authority for tenant, tenant amendments.
P22	34	14.5	897	754	4	23.5	Major trades	Complex laboratory building, experienced customer, careful choice of participants, froze design, supervised; completion on time and within budget.
P9	38	9	200	256	−31	11	High	Re-build after fires; in 2 phases, break between.
P12	52	12.5	415	245	39	24.5	Very low	Design information not complete at start, customers' process was still evolving, day-to-day decisions, good relationships all round.
A6	98	17	407	239	82	32	Very low	By local authority direct labour, inexperience of operatives and management in industrial work.
P30	100	28	2180	240	66	37.5	High	Information not complete at start; large contractor, not industrial specialist, gave job low priority; 15 nominated S/C; 17 domestic S/C; poor supervision.

Contract	Main influences on pre-construction times
Competitive	Briefing: short description of requirements and simple sketch to architects. Client appointed own QS. Approximate bill used, local authority gave planning approval in 3 weeks.
Competitive	Client changed mind after first price quote, too dear; price renegotiated then client delayed decision for 6 months, then needed rapid completion to get grant.
Competitive	Discussion between local management and head office, acquiring site, assessing budget and consulting local planners took 12 months before architect approached.
Negotiated	Initial difficulties as client approached one developer who passed the job to another but briefing still went via the first developer. Client's requirements based on previous building. Negotiation for speed with contractor used regularly by developer.
Competitive	The original parent board approval was for a smaller sum; final design and financial approval took over a year, then planning approval and tendering times average.
Competitive	Completion of land purchase took 8 months; awaited planning approval. Simultaneous tendering for main contractor and steel and cladding sub-contractor. Successful main contractor offered lowest price and shortest time.
Competitive	Five-months wait for planning permission while negotiations on roads took place.
Competitive	Project taken over from another developer with planning approval obtained and design nearly completed.
Competitive	Contractor's work load delayed start for 4 months, time not critical for client.
Competitive	Client chose architect known from previous experience to be good at pre-contract work, drawings and tendering in hand before planning approval obtained.
Negotiated	12 months needed to persuade local authority to allow development. Some amendments made to the design to allow for speedier construction.
Competitive	Land already owned and planning permission straightforward. Client urgency, required completion 14 months after briefing but caused 2-month delay debating costs.
Competitive	Prolonged negotiations with local authority for purchase of site. Then change of site boundaries delayed start by 2 months. Negotiations with design and build contractors before architect employed and competitive tendering. Contractor chosen on price (a period 3 months shorter was offered for 10 per cent more but not tried).
Competitive	Difficulty in determining tenants' requirements and understanding his expectations in respect of the standards and performance of the builder.
Competitive	The site had outline planning permission when acquired. Strong support by industrial development officer gave rapid approvals. Approximate bill used for speed and because site unpredictable.
Negotiated	No bill of quantities, quotations on architect's design and working drawings for speed after client reversed earlier intention of either refurbishing existing building or selling site and decided to develop themselves.
Competitive	Tenant slow making decisions and authorising expenditure.
Competitive	Prolonged delay in granting of detailed planning permission, 11 months after outline approval. This caused original funder to withdraw and there was a further 2 months to find a replacement.
Competitive	Part of local authority programme, and only delay was in re-design after tenant requirements were known.
Competitive	The client already owned the site; he had his own design department which expedited the briefing process.
Competitive	Client urgency speeded pre-construction phase (site already owned), approximate bills used for both phases and negotiation for the second phase contract.
Negotiated	An approximate bill and negotiation with previously used contractor for speed.
Competitive	Tendering was on a full bill of quantities and 52 drawings.
Competitive	Land purchased rapidly from private owner. Then 7 months for design, planning permission and discussion with nominated sub-contractors before going out to tender.

Table C2 Design and build projects

	Site Time				Total time			
Project no	% differs from norm	Actual months	Contract value £000	£/m²	% differs from norm	Actual months	Amount of sub-contracting	Main influences on site times
P8	−53	3	187	134	−38	10	Very low	System built; customer deadline; customer building industry experience. Previous use of contractor.
P10	−51	3.5	271	232	−35	11.5	Low	Canteen refurbishment, speed essential. National contractor, amended client's design for speed.
P7	−39	3.5	130	221	−47	8.5	Low	System built, contractor industrial specialist used before. Client urgency, experienced site foreman, flexible workforce.
P15	−29	6.5	563	202	−31	15.5	Low	Experienced client with continuous building programme, but his first design and build project. Contractor chosen on time and design skills.
P34	−20	12	2900	449	−19	21	High	Method chosen by client after recent experience of a slow traditional project. Co-operation and motivation of client and contractor teams gave a successful result.
A2	−14	5	96	178	−3	18	Major trades	Building system used; client local authority.
P28	−13	11	1683	302	−25	17	Major trades	Contractor chosen on reputation as well as price. Two part contract to allow time for services design.
P35	−11	17	11950	378	−10	27	Low	Separate contracts for shell and fitting out. Sub-contractors chosen for performance and speed. High client participation, few alterations.
A20	−10	13.5	2700	252	2	26.5	High	Problems with ground and weather, but good site supervision overcame difficulties.
P19	3	10	704	210	2	23	High	All work sub-contracted and site supervision not commensurate. Many client variations which could have been accommodated better if the architect had been 'in-house.'
P13	3	9	494	148	31	23	Low	Contractor chose pre-cast slabs, floor finish etc for speed. Steel strike and client changes caused minor delays.
P31	11	17	2233	774	15	26	High	Client's amendments and plant and machinery installers directly appointed by the customer caused some delays, but good team work built up over many previous contracts overcame difficulties.
P5	20	6.5	114	137	−28	11.5	Very low	There were a number of client changes but a flexible construction team working with a familiar system produced completion in the planned time.
P18	20	12	703	504	46	33	High	Complex laboratory and office building; client slow making decisions, nominated S/C caused delay.
A19	27	18	2150	180	42	32	High	Tenant alterations; ground problems; material deliveries; hold-up on gas supply.
A9	30	12	510	148	4	23.5	Most	Tenant alterations; local authority client allowed long period; contractor's main experience in other types of work.
A11	37	13	555	113	−12	20	Low	Tenant alterations, steel strike and extensive siteworks determined long contract period.
P2	53	75	83	146	13	15.5	Major trades	Local authority, building for tenant, decided on long time scale; rigid specification, no opportunity for contractor to improve buildability.
A1	118	12	90	134	50	24	Low	Tenant alterations; inexperienced contractor, poor supervision; sub-contractor problems; client local authority.

Contract	Main influences on pre-construction times
Negotiated	Initial purchase of land from local authority took 2½ years. Decision to build when grant available. Then for speed negotiation with contractor used previously. Planning and building regulations approvals sought as construction commenced.
Negotiated	Initial scheme by outside architect rejected because of high cost. After revised brief to cut costs, negotiations of contract to save time.
Negotiated	Contractor asked to repeat previous design but two other quotations obtained as a precaution. Rapid planning permission but amendments to design to satisfy fire regulations.
Competitive	Client wrote 22-page specification. Preliminary drawings by client's architect and quality surveyors, estimate of cost before going out on design and build for 3 quotations.
Negotiated	Four months for discussions and preliminary design, with visit of contractor to customer's parent factories to ensure that they understood customer's requirements and standards.
Competitive	Specification and outline drawings by planning department, then 4 months before tenders sought, 2 months before acceptance, then contractor had to obtain approvals before confirmation 3 months later.
Competitive	Original performance specification by a continental consultant used before. Three quotations obtained for design and build. Three-month examination of proposals to avoid changes after the start.
Negotiated	Local estate agent used to acquire land and arrange funding. Co-operative planning department assisted with the assembly and purchase of land from various owners.
Negotiated	Discussions with planning department took 7 months. The funder asked for layout alterations.
Competitive	Design and build was chosen by the overseas client after an estimate from an architect was considered too dear. The contractor used an outside architect.
Negotiated	Local design and build contractor chosen through personal contacts to produce sketch plans and apply for planning approval. Contract signed 6 months after initial briefing.
Negotiated	Client required speed and his architect approached their regular contractor before the site was chosen. A nominal price accepted before all process decisions made to allow an early start on site. Contractor's own design group produced the detailed designs.
Negotiated	Negotiated agreement with contractor, no formal contract. Few drawings produced. Client urgency due to grant deadline.
Negotiated	The contractor/developer owned the land and initially the client hoped to buy it and build themselves. The contractor then offered a design and build service and after briefing offered 3 alternative designs. After acceptance and planning approval the client withdrew and 3 months later returned for simpler project.
Negotiated	The developer had difficulty obtaining funding. Investigation of the site difficult owing to existing buildings. Full bill of quantities produced to protect the developer's interest.
Negotiated	Negotiated contract with a designer and contractor used successfully before.
Negotiated	After offer of the site the developer asked his regular contractor for proposals; these were modified by the client's project manager to suit anticipated demand and a contract price negotiated.
Competitive	Unit taken over from another public body and design amended for a new tenant. Competitive quotations from 6 firms. After approval of the specification of lowest tenderer, delays of 2 months for obtaining bond and building regulations approval.
Competitive	Six months for development of brief; council approval; 5 tenders obtained based on detailed local authority specification.

Table C3 Projects with separate management function

	Site Time				Total time			
Project no	% differs from norm	Actual months	Contract value £000	£/m²	% differs from norm	Actual months	Amount of sub-contracting	Main influences on site times
P11	−33	5.5	412	227	−43	10	Separate packages	By local authority for tenant needing space urgently; national contractor as manager to get rapid action; good co-operation to solve ground problems, tenant changes.
P27	−27	9	1507	279	−42	13	High	Client deadline; contractor chosen on time and cost. Good co-operation solved problems of statutory undertakers, client changes, sub-sub-contractors.
P32	−12	12.5	2259	416	−18	18.5	Very low	Client asked for a very short period; well organised contractor dealt with client variations.
P29	−11	12	1935	75	−42	13	Separate packages	Client set a fast time but market changes led to alterations and reduced urgency.
A4	−1	7	245	124	−23	12.3	Low	A contractor well-established in the area, employing his own key workers and regular sub-contractors, overcame problems and dealt with client alterations successfully.
A21	−3	15	3500	174	−2	26	High	An experienced contractor overcame ground problems. Difficulties with statutory authorities and sub-contractors delayed final stages.
P25	5	12.5	1306	413	33	30.5	Major trades	A job with complex services where the role of the project managing consultants was vital for dealing with changes and putting pressure on sub-contractors.
P14	28	11.5	530	127	44	32.5	High	Contractor new to the area was not able to get good sub-contractor; inexperienced site agent, so poor supervision. Many variations.

Table C4 Management in-house by the customer

	Site Time				Total time			
Project no	% differs from norm	Actual months	Contract value £000	£/m²	% differs from norm	Actual months	Amount of sub-contracting	Main influences on site times
A13	–30	7	703	198	–36	14.5	High	Client local developer with financial incentive; strong control of sub-contractor by client's contract manager.
P4	–6	5	106	211	–41	9.5	Separate packages	A partner in the client firm took responsibility for managing the project, with technical assistance from the architect. Enthusiasm and good relationships contributed to the project's success.
P3	–4	5	99	127	134	37.5	Separate packages	Some snags due to client's inexperience; materials not ordered in time, friction with sub-contractors, poor workmanship, but time about average.
A15	16	13	977	137	2	23	Major trades	Developer and contractor associated companies; steel strike; design changes; rushed start meant pre-preparation poor.
P1	97	65	25	133	66	26.5	High	Small project, an element of self-build resulted in slow progress.

Contract	Main influences on pre-construction times
Separate packages competitive	The project management system allowed work to start before design details were completed; approximate bills. Previous use of firm by la architect.
Competitive	The client's urgency allowed only 3 months' preparation time; consultants previously used by the project manager and accepted the short time.
Competitive	Site start before completion of working drawings.
Negotiated	High level of co-operation by local authority gave rapid processing of permits. Design similar to previous, so progressed quickly. Also nominated same sub-contractors as on previous project.
Competitive	Planning permission already obtained at time of earlier phase. Long standing co-operation between client, project manager and consultants. The contractor offered the shortest time as well as the lowest price.
Building contract competitive	Some design changes to simplify construction.
Competitive	Proposals had to go through the client's parent company overseas. Main contractor and nominated S/C work let competitively. The consultant's, recommended by a similar manufacturer, designed building and process plant.
Building contract competitive	The local authority was unwilling to sell the land, and negotiations took 19 months.

Contract	Main influences on pre-construction times
Structure competitive package	Site suggested by developer's contract manager. Plans were modified before the start to suit a prospective tenant.
Separate packages competitive	The client searched for a suitable site for 3 years. Because of the residential area of the site bought, the planners advised on the design details. Own management decided on after high estimates obtained.
Separate packages competitive	Own management decided on after competitive quotations considered too dear, client heard of another industrialist saving 25 per cent by using this method.
Negotiated	Site taken over, with planning permission, from another developer who had been unable to obtain a funder.
Negotiated sub-contract work	Estimates of cost were too high for client and then the architect was asked to make the design suitable for part self-building. Planning approvals caused some delay.

Appendix D

The opinion survey

As a parallel exercise to the case studies and statistical analysis carried out by the Building Research Establishment, Kenchington Little and Partners interviewed representatives of 17 organisations concerned with the construction of industrial buildings. All the organisations were known to have a wide experience of industrial building and/or have completed one or more projects unusually rapidly.

Contributors were asked to express opinions on what aids fast construction and what causes delays. The discussions were structured so that each stage of a project was reviewed but contributors were not asked specific or leading questions. The opinions recorded are only those which the contributors considered sufficiently important to volunteer. These opinions have been grouped under various loose headings and set out in tabular form.

In addition to the discussions with the 17 organisations in the construction industry, three of the industry's customers were interviewed and asked what experiences they had had when building in the UK and what service they would like to see from the industry. These opinion are summarised separately.

Opinion survey – customer experience

1 Three companies were interviewed. They were all manufacturers who operate in the UK and overseas and had experience of building factories in several countries. The industries in which they operated were clothing, electronics and pharmaceuticals.

2 All three had carried out developments in various stages over a number of years. The methods used to obtain the buildings were different for each company. They were:

Company i
Land owned by a public development organisation.
Design, contract administration and supervision carried out by the development organisation.
Construction by a contractor following competitive tender.

Company ii
Land owned by a public development organisation.
Design, contract administration and supervision carried out by private professional practices.
Construction by a contractor following competitive tender.

Company iii
Land owned by company.
Design and construction by design-build contractor following competitive tender against a performance specification.
General supervision and close involvement in contract by the knowledgeable customer.

3 These methods produced the following experiences:

Company i
Very poor service with faulty designs, poor construction, inadequate services, cost and time over-runs, interface problems between phases and inadequate recompense for poor workmanship.

Company ii
Time and cost over-runs on early phases but these were reduced by the appointment of a project manager for the most recent phase. Even so, it was necessary to bring in an overseas practice to advise on changes to bring the design within budget. Generally, satisfactory buildings have resulted but the customer was irritated by the effort required to have the many faults remedied during the maintenance period. Co-ordination of services had been a problem and 'as built' drawings were inaccurate.

Company iii
Having tried various methods this company used design-build with considerable involvement of their own staff in assembling the brief and supervising the work. They find that they get a satisfactory building delivered on time and reasonable value for money. They do not consider that construction in the UK is more difficult than other countries and do not regard it as a problem.

4 None of the companies complained about problems in obtaining planning approval. However, one of them felt strongly that the building and fire regulations were too onerous and that the fire officers' requirements were random and illogical with no effective court of appeal.

5 The two companies who were less successful in their relationships with the industry both wished to concentrate on their own speciality and were dismayed by the amount of effort required to procure a building. The third 'successful' company illustrated how a knowledgeable and forceful customer can achieve good results in the UK.

The opinion survey

	Contributor	General	The customers	Method	Management
1.	Public Developer	Speed only required occasionally. Cost generally more important.	Single high level decision maker required from user if purpose build.	If speed required use design-build contract with tender to a performance specification.	Appoint a project manager in house or with consultant.
2.	Public Developer	Cost & accountability more important than speed.	A firm full and final brief is required early. No changes should be allowed after approval of design.		Responsibility of team leader, normally an Architect.
3.	Project Manager	Too stringent building & fire regulations plus uneconomic planning requirements are a major cause of delay. The industry generally performs well.	A clear initial brief is required. Subsequent changes to be carried out and paid for under a separate contract.	Traditional method satisfactory if well managed.	Vet designers & contractors thoroughly. Prefer multi-discipline design practices with Engineering bias.
4.	Estate Agent	Industrial buildings are generally required immediately so have to be supplied by existing/ advanced unit.	Clash of requirements between user & funding body over specific needs v relettable specification. Funding body wins.		
5.	Architect	Speed is not the major requirement of most projects.	Full brief including max. cost required at outset. Customer must appoint a single senior man with the authority to make decisions to join the building team.	Involve reputable contractor early.	Full & final information to be ready for contractor on day 1 of contract. A clear programme should be established with main contractor including sub-contractor work & submission of specialist drawings.
6.	Multi-discipline Practice	Speed is not generally a major factor in most projects.	If speed is important the customer must accept the disciplines & other consequences. Very full brief required giving priorities as well as tech. & cost requirements.	Traditional method is satisfactory. Package deals can work but failures have occurred and an independent adviser should be appointed.	Team must be experienced and have worked together before. Vital that contractor brought in early. Detailed programming & monitoring is required. Engineers should manage industrial projects.
7.	Civil & Structural Consulting Engineer	Speed is not generally wanted. Customers prefer to have time to think.	Full brief with priorities required. Customer must understand that he cannot have speed, economy and fulfil a tight brief.	Negotiated contracts, design-build or management contracts are all successful methods but contractor must be involved early.	Full team must be committed to success. An experienced & tough project manager must be appointed.
8.	Quantity Surveyor	Speed less important than value for money. Whole life costs should be considered.	Clear brief required at outset. Customer must be aware of very serious effect of changes. A senior decision maker is required within the customers organisation to become part of the building team.	Involve contractor at outset or on completion of design. Design-build with independent QS favoured. QS and customer capable of preparing a performance specification to use to obtain tenders.	Project management rests with contractor in design-build system. Successful contracts are built around people. This is difficult to guarantee. Architects are poor project leaders for industrial buildings.
9.	M & M Services Consulting Engineer	Complexity of modern services not understood & management capability is inadequate in the industry. The M & E profession & its training system require overhauling.	Customers should be aware of disruptive effect of changes and be prepared to pre-order long delivery items.	For speed use performance specification, open selection of equipment, a flexible contract & negotiation.	Strong commercially minded project management is required for the whole building process with an appreciation of the needs & complexity of the M & E services.
10.	Design-build Specialist Contractor	Posturing for claims is the scourge of the industry.	Financial realism & full commitment required at all stages. Any changes required have to be signed for with cost and delay implications spelled out.	Design-build with single contract responsibility. Recommend appointment of independent QS for cost monitoring. Careful planning & resource scheduling.	Full integrated design team including planning engineer in one office from day one. Realistic cost should be known from early stage. Site management involved early.
11.	National Building Contractor	UK preoccupation with competition is counter productive & increases costs in the long run.	Must become heavily involved and insist on good standard of performance.	Design by consultants but negotiate contract & involve contractor early.	Careful selection of design team & contractor based on track record and ability to work in harmony with customers & each other.
12.	National Building Contractor	Speed generally not important to client. Cost is the ruling factor.	Clear well defined brief required at outset. No changes should be required during construction.	Both design-build and traditional consultant-contractor relationship can work well.	Experienced, compatible team should be appointed. Contractor should be involved early. High level, competent staff required on site.

esign	Forms of contract & contract documents	Sub-contractors	Construction	M & E Services
ossible advantages of off ite fabrication lost due to roblems with security of ayments. Bricks & mortar re liked. Too simple uildings lose demand.	JCT without quantities and NFBTE design-build are both satisfactory.	The advantages & disadvantages of using nominated sub-contractors balance out.	Cooperation preferable to coercion.	M & E a problem. Full design should be done by consultant. Performance of statutory authorities poor & unaccountable.
tandardise. inimise wet trades. chieve early eatherproof envelope. se composite cladding.			Main impetus should come from contractor.	as above.
teel frame preferred. aintenance free period f 25 yrs. required. High uality required for arketing.	If speed required negotiate contract.	Do not allow use of nominated sub-contractors. Main contractor may be required to choose from list of 4-6 specialists for his domestic sub-contractor.	Construction time not a problem.	Have devised a system by which M & E services are designed in full by consultant & specialist sub-contractor against a target cost.
esign governed by unding body require- ents not by use & speed f construction i.e. steel rame 20′ eaves, clear pan, brick block walls.				
esign for speed. Avoid arge numbers of nterdependent trades.	Management contract recommended. Splitting project into a number of main contracts not recommended. Present standard forms of contract are 'adversary' type.		Changes are a major cause of delay.	M & E to be fully designed by consultant including equipment selection & pre-ordering of long delivery items.
esign should be simple ith generous tolerances.	JCT & ICE standard forms OK. Negotiate rather than tender for speed.	Avoid nominated sub-contractors. Early appointment of contractor allows all SC's to be domestic.		
oose fit design essential. esign should take into ccount contractors dvice on materials & ethods.	Standard RICS, BOQ's cause delays. Use civil engineering bill or schedule of rates.			Statutory undertakers are unpredictable. M & E services are a problem. The existing system does not work.
	Own adaptation of standard design-build contract recommended. Responsibility rests with contractor under a lump sum contract.	Avoid nominated sub-contractors. They reduce controle & clout of the main contractor.		
etailed design requires nowledge of which akes of equipment will e used. Changes are very isruptive.				
esign must be flexible for uilders work required by rocess plant. Information lways late/inaccurate.	Management target cost contract gives value for money & allows larger contractor management with local contractor skills & labour. Fewer & less detailed drawings required with design build.	Design responsibility limited due to interface problems.	Start on site prior to completion of design. Pre-order plant, chase & check continuously.	Designed fully by design team around equipment chosen & ordered early.
Design should be simple, buildable and use as many standard components as possible. Design should allow for a high use of plant.	UK forms of contract result in team fighting one another. Simple contract required which will produce harmony.	Specialists must appreciate other peoples requirements and become part of a team. The use of nominated sub-contractors reduces scope for competition in main contract.	Greater flexibility & commitment is required by workers & staff.	Standardise & Simplify.
Adequate tolerances required for speed. Simple design & an early weather-tight envelope should be aimed for.	Design-build contract results in right type of relationship in building team. Approximate BOQ's are adequate.			M & E consultants serve no useful purpose. Co-ordination of services should not rest with the main contractor.

The opinion survey (continued)

	Contributor	General	The customers	Method	Management
13.	National Civil Engineering Contractor	Speed is not often required. Contractors have no incentive to improve on suggested contract periods.	Customer must make up his mind & stick to it. A single senior decision maker is required in the customers oganisation.	Management style of contract gives good performance and value for money.	Involve contractor early. Engineers should be the project leaders.
14.	Regional Building Contractor	There is a demand for fast construction amongst industrialists. Many contracts specify too long construction periods which can be shortened with advantage.	A senior liaison man/decision maker is required in the Customers organisation.	Package deal with independent QS recommended.	Detailed programme & resource schedule plus subsidiary programmes from suppliers should be prepared & monitored.
15.	Regional Building Contractor	Speed not generally required. Most building by funding bodies is to act as asset base so conservative design required. Purpose build customers like an identifiable building.	If speed is required then Customer must accept disciplines of rapid decisions, no changes etc. All relevant people must accept this.	Package deal. Contractor to appoint Architect and consulting engineer with proven working relationship.	Programme & management should aim at certainty.
16.	National Steelwork Contractor	Speed is not generally a requirement by itself. Customers are more interested in cost but do not appreciate the link between speed & cost. Often high speed results in lower costs.	It is important to obtain a commitment from the customer to a fixed scheme.	Competitive tender at early stage against scheme drawings, performance specification & approximate BOQ's. Consultants vet contractors details.	Design team to produce broad concept. Detail design left contractors. Strong commercially minded project manager is required. Involve contractor early.
17.	National M & E Services Contractor	Modern construction management is inadequate to deal with complex services. Many jobs finish on time & poor reputation of M & E services is unjustified.	Customers cause many delays by not providing information or changing their minds. Late decisions about the equipment to go in a building have a knock-on effect on the services.	Design-construct approach for services best with direct customer contact. Costs should be monitored by an independent QS.	Careful selection of a compatible team is required. Detailed programmes should be prepared. A strong project manager must be appointed.

esign	Forms of Contract & Contract Documents	Sub-Contractors	Construction	M & E Services
oid changes of trade as r as possible.	The standard conditions are built around the assumption that changes will occur. Contracts should severely limit changes.	Nominated sub-contractors reduce the control of the main contractor.		Statutory authorities are uncontrollable both for cost and programme.
etailing should be mple. Wet trades should avoided if possible. esign should use aterials currently ailable.	NFBTE package deal contract satisfactory. ICE & JCT forms lead to claims rather than problem-solving. Selective tendering leads to adversary contracts.	Nominated sub-contractors should be avoided.	Flexibility required from work force i.e. factory constructors rather than traditional trades. Skilled trade foremen are in short supply. Variations cause delays.	Disillusioned with role of M & E consultant. Use specialist sub-contractor for design. Statutory undertakers are a problem. They should be obliged to enter into a contract.
onservative and aditional designs are ouble-free & reliable.	JCT forms of contract OK. The contract is only important when things have gone wrong.	Traditional tradesmen working for the main contractor are preferable to sub-contractors.	Pre-order long delivery items at customer's risk. Greater flexibility of labour required to enable main contractor to keep control of all trades.	Design & Construction by specialist sub-contractor preferred system.
est system is semi- andard, highly pre- ngineered design using andard details. Poor etails are major cause of elay.	Contractors should be asked to tender against a performance specifications. Contract should allow for a team to be built rather than adversary type.	Sub-contractors skills & standard details should be used more fully.		
esigns must allow for ompetition between uppliers & partial ommissioning if a long ommissioning period at nd of contract is to be voided.	JCT forms satisfactory. BOQ's prepared by QS or consultants often incomplete, resulting in subsequent extras.		Pre-ordering by consultants normally ineffective since suppliers only act against a firm commitment.	There is a move towards standardisation in UK but this will bring a drop in quality of the environment.

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Appendix F Membership of the Steering Group of the Building EDC

Chairman

D T Routh	Director, Construction Industry, DoE

Members

I Dunstan	Director of BRE
J Bobrowski	Senior Partner, J Bobrowski & Partners
A Black	National Officer, UCATT
T Duston	Regional Director, Shepherd Construction Ltd
L Moore	Managing Director, Atcost Ltd
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G Van Lottum	Deputy General Manager, Design and Construction, Slough Estates Ltd
G Graham	Senior Partner, Architects' Design Group
C J Groome	Secretary, Building and Civil Engineering EDCs, NEDO

Secretariat

A G Balls (to 5 October 1982), then I G Urquhart R Gray (to 27 May 1982), then N Sanders	Department of the Environment

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M A Clapp (to 1 July 1982) then A G Simms
H J Purkis
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